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THE EXECUTIVE COMMITTEE OF THE CONTINUOUS MORTALITY INVESTIGATION BUREAU

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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 ninth number of its Reports.

The main item is a report on the graduation of the mortality experiences for the quadrennium 1979–82 for assured lives, annuitants and pensioners. This has to be read in conjunction with a paper prepared by three members of the Committee, entitled 'On Graduation by Mathematical Formula', by D. O. Forfar, J. J. McCutcheon and A. D. Wilkie, which is being published in *J.I.A.* and in *T.F.A.* This paper describes the methodology used by the Committee in preparing its graduations of the experiences.

The Committee is seeking to obtain the views of members of the actuarial profession on these graduations at meetings of the Faculty and of the Institute. It is also obtaining the views of those offices that contribute to the Bureau. The views of anyone else will be welcome. After the Committee has taken soundings in this way it will consider what new standard tables of mortality to publish. The report is therefore an important one for the future.

A second item reports on the Cause of Death experience for assured lives for the quadrennium 1979–82.

The Executive Committee wishes to thank all those whose efforts have made it possible to produce these reports—those in contributing offices who prepare the data, the staff of the Bureau and of the associated consulting firms, and those who have overseen the printing and publication of this number of the Reports.

A. D. Wilkie
Chairman of the Executive Committee

January, 1988

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THE GRADUATION OF THE 1979–82 MORTALITY EXPERIENCES

1. INTRODUCTION

1.1 INTRODUCTION

In 'Mortality of Assured Lives, Pensioners and Annuitants 1979–82', C.M.I.R. **8**, 1, the Committee reported on the results of all the mortality experiences for assured lives (accepted at normal premium rates), annuitants, and life office pensioners for the quadrennium 1979–82. This quadrennium lies some twelve years after the quadrennium 1967–70, the experience for which formed the basis for the standard tables for male assured lives (A1967–70), annuitants (a(90)), and life office pensioners (PA(90)), which have been used by the Committee for comparisons, and life offices for practical applications, since they were published.

The quadrennial report showed that the actual mortality experience for all these investigations had moved out of line with the standard tables. The experience of some new investigations is also now available. Furthermore, the a(90) tables for annuitants and the PA(90) tables for life office pensioners were intended to represent the mortality rates likely to be experienced in 1990, and so they are unsuitable for use, without adjustment, for the calculation of premium rates and reserves for those who may live well beyond that date.

The Committee therefore decided that it was appropriate for all the investigations for which an experience was available for 1979–82 to be considered with a view to preparing tables of the graduated mortality rates that best represented those experiences. This Report presents the results of the Committee's investigations.

The Committee has been helped by the fact that three of its members have prepared a comprehensive paper on the mathematical methods suitable for graduation in modern conditions, i.e. taking into account both modern statistical ideas and modern computing facilites. The authors of that paper were able to use the C.M.I. experiences as examples of the methodology. Since the methodology is fully described in the paper, 'On Graduation by Mathematical Formula', by D.O. Forfar, J.J. McCutcheon, and A.D. Wilkie, J.I.A. **115**, 1 and T.F.A. **41**, 1, it is possible for the Committee in this report to take the methods as known, and simply to describe the results. The documents are distinguished by calling them the 'Report' and the 'Paper'.

The development of this modern methodology has been a continuing process, in which the Committee has played a significant role. The historically-minded reader is referred to 'Considerations Affecting the Preparation of Standard Tables of Mortality', J.I.A. **101**, 133 and T.F.A. **34**, 135, 'The Graduation of Pensioners' and of Annuitants' Mortality Experience, 1967–70', C.M.I.R. **2**, 57, 'Proposed Standard Tables for Life Office Pensioners and Annuitants', C.M.I.R. **3**, 1,

'Graduation of the Mortality Experience of Female Assured Lives 1975–78', C.M.I.R. **6**, 1, and 'On a Possible Graduation of the Irish Assured Lives Mortality Experience', C.M.I.R. **6**, 37. From these papers it can be seen how various new methods have been developed and introduced to the profession.

1.2 QUESTIONS FOR THE PROFESSION

This Report presents graduated experience mortality rates. The Committee wishes to present these results for consideration by the profession before the Committee attempts to construct standard mortality tables based on these graduated experiences. To do this would require that the tables be extended where necessary to lower and to higher ages than appear in each experience, in order that rates may be available for the complete range of ages that is necessary for practical applications. It would also require that forecast rates be prepared wherever they may be required.

The Committee therefore seeks the views of the profession on these graduated experiences, and on whether standard tables based on these experiences are required. If the response is positive it will then arrange for standard tables to be constructed and will report back to the profession when the necessary work has been completed.

For each investigation the Committee would like to know the profession's views on a number of specific topics. Certain 'Questions for the Profession', relating to each particular experience, appear at the end of each Section of the Report. Most of the questions are, however, common to each investigation and these are listed below.

(1) Are the graduated rates derived from each particular 1979–82 experience sufficiently different from those of existing standard tables for new standard tables to be prepared, which would be used by the Committee as a standard of comparison in future, and which could be used by actuaries working in or advising life offices for the calculation of premium rates and reserves?

(2) The Committee is aware of the work of the AIDS (Acquired Immune Deficiency Syndrome) Working Party of the Institute of Actuaries, and the profession has been informed of this work through the Bulletins issued recently by that Working Party, and through some common membership. If mortality rates at younger adult ages are likely to rise because of AIDS, will a new standard table be of any practical use? If not, will it nevertheless be useful as a historical record of mortality rates before the arrival of AIDS?

(3) If a standard table is desired for a particular class of life, which select period should be used? Existing tables include those with no select period (PA(90)), a select period of one year (a(90)), two years (A1967–70 and FA1975–78) and five years (A1967–70(5)). How important is it for practical calculations that the same selection period as in a previous table be retained?

(4) In most cases the observed experience covers a narrower range of ages than may be necessary for practical work. Standard tables would need to be

extended downwards and upwards, as necessary, to satisfy practical requirements. What range of ages is in fact necessary for each table? It need not be the same for the select tables as for the ultimate table.

(5) The Committee will wish to have guidance on the form in which standard tables should be presented. For each standard table that is produced, values of mortality functions would be published. But do those who use the tables require full sets of monetary functions at a range of rates of interest, as was customary in the past and as was published for A1967–70, $a(90)$ and PA(90)? For the standard table for female assured lives, FA1975–78, the Committee took the view that mortality functions were all that was required nowadays, in view of the great increase in computing power available to offices. Now that the same sort of computing power is available to any individual who wishes it, is there any requirement for extensive tables of monetary functions to be published? If the Committee feels that printed tables of monetary functions are required, it will take further soundings about what functions would be desired. However, any preliminary indications of what monetary functions would be wanted would be helpful.

2. THE DATA

The number of investigations carried out by the Committee has grown substantially over the years. The best measure of the size of an experience (for the purposes of graduation) is given by the number of deaths recorded in the period of observation. A satisfactory graduation can be expected whenever the number of deaths is large enough. In practice 100 deaths spread over a short age range, or 200 spread over a longer age range often proves sufficient. If an investigation has many fewer deaths than these numbers, the estimated parameters of any graduation formula have such large standard errors that there is too great uncertainty about the shape and level of the graduation function for the results to be of great practical reliability.

Table 2.1 summarises all the investigations considered by the Committee by showing the numbers of deaths, subdivided by duration where this is recorded. It will readily be observed that the numbers of deaths for several of the investigations are so few that there would be no possibility of basing a satisfactory graduation on them; nevertheless there are over 100 data sets shown in the table for which there are over 100 deaths, without taking into account the possibility of grouping different durations together.

The experiences that, for the 1979-82 quadrennium, were considered to be too small to warrant individual graduations are:

Females.	United Kingdom.	Level temporary assurances.
Females.	United Kingdom.	Decreasing temporary assurances.
Males.	Republic of Ireland.	Linked assurances.
Females.	Republic of Ireland.	Permanent assurances.
Females.	Republic of Ireland.	Linked assurances.
Males.	United Kingdom.	Pensioners' widowers.

For several investigations the Bureau collects data on an 'Amounts' basis as well as on a 'Lives' basis. These are: immediate annuitants, life office pensioners, and the widows and widowers of life office pensioners. These too required consideration, and the 'Amounts' and 'Lives' data are discussed together.

The Committee was faced with a substantial task in attempting to carry out its aim of preparing graduations of all the experiences, and although this has been facilitated by excellent computing facilities and the suites of programmes developed specially for the work of graduation, there remains the problem of presenting the results of this work in a sufficiently succinct form. The Committee hopes that it has chosen the correct balance between profusion and terseness. Many more details of each graduation are available to the interested researcher on request to the Bureau.

Most of the investigations are for United Kingdom data; some are for policies in the Republic of Ireland. When data for Ireland are under discussion this fact is noted, but the opposite observation is not repeated for the UK investigations.

Table 2.1. *Numbers of deaths observed during* 1979–82 *in each investigation.*

A. Males. Assurances. United Kingdom.

Investigation	Durations 0	1	2	3	4	5+	Total
Permanent assurances:							
Medical	193	278	328	435	451	30,488	32,173
Non-medical	1,602	2,009	2,060	2,074	2,155	52,950	62,850
Combined	1,795	2,287	2,388	2,509	2,606	83,438	95,023
Level temporary assurances:							
Medical	70	65	63	61	53	192	504
Non-medical	194	162	128	134	87	305	1,010
Combined	264	227	191	195	140	497	1,514
Decreasing temporary assurances:							
Medical	66	73	90	107	91	1,313	1,740
Non-medical	177	239	260	301	266	3,158	4,401
Combined	243	312	350	408	357	4,471	6,141
Linked assurances:							
Medical	13	21	11	26	26	332	429
Non-medical	73	63	62	83	84	1,183	1,548
Combined	197	166	147	159	159	1,906	2,734
(including many not categorised by medical type)							

B. Females. Assurances. United Kingdom.

Investigation	Durations 0	1	2	3	4	5+	Total
Permanent assurances:							
Medical	38	74	54	66	63	1,074	1,369
Non-medical	383	527	516	457	450	3,688	6,021
Combined	421	601	570	523	513	4,762	7,390
Level temporary assurances:							
Medical	1	0	0	0	0	2	3
Non-medical	2	1	1	2	0	0	6
Combined	3	1	1	2	0	2	9
Decreasing temporary assurances:							
Medical	0	1	2	1	2	1	7
Non-medical	2	1	1	1	1	4	10
Combined	2	2	3	2	3	5	17
Linked assurances:							
Medical	5	3	4	1	5	40	58
Non-medical	9	14	26	25	28	184	286
Combined	40	27	35	27	34	256	419
(including many not categorised by medical type)							

Table 2.1 (*continued*)

C. Males. Republic of Ireland.

Investigation	Durations 0	1	2	3	4	5+	Total
Permanent assurances:							
Medical	12	19	23	27	32	2,388	2,501
Non-medical	69	60	59	64	60	1,889	2,201
Combined	81	79	82	91	92	4,277	4,702
Linked assurances:							
Medical	0	1	1	1	2	52	57
Non-medical	17	26	22	11	16	131	223
Combined	17	27	23	12	18	183	280

D. Females. Republic of Ireland.

Investigation	Durations 0	1	2	3	4	5+	Total
Permanent assurances:							
Medical	0	0	2	0	0	12	14
Non-medical	2	2	0	1	3	18	26
Combined	2	2	2	1	3	30	40
Linked assurances:							
Medical	0	0	0	0	0	8	8
Non-medical	3	3	2	3	0	19	30
Combined	3	3	2	3	0	27	38

E. Immediate annuitants. United Kingdom.

Investigation	Durations 0	1	2	3	4	5+	Total
Immediate annuitants: Males							
Pre-1957						217	217
Post-1956	122	142	169	180	157	4,123	4,893
Combined	122	142	169	180	157	4,340	5,110
Immediate annuitants: Females							
Pre-1957						1,758	1,758
Post-1956	154	196	240	271	281	8,801	9,943
Combined	154	196	240	271	281	10,559	11,701

F. Males and Females. United Kingdom
(Not subdivided by duration).

	Males	Females
Retirement annuitants:		
Deferred	12,328	860
Vested	8,811	692
Combined	21,139	1,552
Life office pensioners:		
Normal and late retirements	85,426	10,536
Early retirements	23,717	1,899
Combined	109,143	12,435
Widows and widowers of life office pensioners:		
All	10	692

The experiences (other than those that are too small to consider) are discussed in the following Sections of this report in the sequence in which they are listed in Table 2.1, that is:

A. Males. United Kingdom.
Section 3. Permanent assurances.
Section 4. Temporary assurances (level and decreasing).
Section 5. Linked assurances.

B. Females. United Kingdom.
Section 6. Permanent assurances.
Section 7. Linked assurances.

C. Males. Republic of Ireland.
Section 8. Permanent assurances.

E. Males and Females. United Kingdom.
Section 9. Immediate annuitants
Section 10. Retirement annuitants.
Section 11. Life office pensioners.
Section 12. Widows of life office pensioners.

Section 13 gives some comparisons of the various experiences, particularly those for annuitants, and in Section 14 the graduated values of q_x are shown in synoptic tables, along with those from the current standard tables.

Certain methods have been used in all the graduations presented. Except where it is noted otherwise, the function μ_x has been graduated, using central exposures, with maximum likelihood estimation of the parameters. All the GM(r,s) and LGM(r,s) formulae use Chebycheff polynomials in the transformed variable $t=(x-70)/50$. Thus

$$\mathrm{GM}^{r,s}(x)=a_0+a_1C_1(t)+\cdots+a_{r-1}C_{r-1}(t)$$
$$+\exp[b_0+b_1C_1(t)+\cdots+b_{s-1}C_{s-1}(t)],$$

where $C_i(t)$ is the first type of Chebycheff polynomial of degree i in t, and

$$LGM^{r,s}(x) = \frac{GM^{r,s}(x)}{1+GM^{r,s}(x)}$$

(See Section 4 of the paper.)

Wherever it is appropriate to group ages for comparisons they have been grouped so that the numbers of actual deaths or the numbers of expected deaths (as appropriate for the test) are at least 5 in each age group.

Where the experience is subdivided by duration, the notation '5+' is used to mean 'durations 5 and over', and where durations are grouped a similar notation is used, so that for example durations 2, 3, 4 and 5+ combined are referred to as duration 2+.

3. PERMANENT ASSURANCES, MALES

3.1 INTRODUCTION

The investigation into the mortality experience of male lives assured in the United Kingdom for permanent assurances (whole-life and endowment assurances) is the oldest carried out by the Bureau, and it has formed the basis for several sets of standard tables for assured lives, A1924–29, A1949–52, A1967–70 and A1967–70(5). It is also the largest investigation, measured either by exposed to risk or by numbers of deaths.

This experience formed one of the examples used by the authors of the Paper and fuller details of the graduation are reported therein. In this Report it is therefore possible to be relatively brief.

The investigation is based on policies, and therefore contains a considerable number of duplicates. The numbers of duplicates in the exposed to risk are not known, but it is possible to analyse the records for deaths in the Cause of Death investigation to obtain a distribution of numbers of deaths with 1, 2, 3, . . . policies, as the Committee reported in 'An Investigation into the Distribution of Policies per Life Assured in the Cause of Death Investigation Data', C.M.I.R. **8**, 49 (1986). Variance ratios appropriate to the actual experience have been calculated and used to adjust the exposed to risk and numbers of deaths, as described in the Paper.

The experience includes data for a select period of five years and an ultimate period thereafter, so there are six different sets of duration data, for durations 0, 1, 2, 3, 4, and 5+.

The A1924–29 table was constructed with a three year selection period. For the A1949–52 table this was reduced to two years. The A1967–70 table came in two forms, one with two years and the other with five years selection (A1967–70(5)).

3.2 THE DATA

The experience is divided into Medical and Non-medical sections, and the 'Combined' section is the aggregate of these. The numbers of deaths and the central exposed to risk for each section and for each duration (including 2+) are shown below.

	Medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	193	119,690.5	1,602	1,679,349.2
1	278	139,098.5	2,009	1,636,959.8
2	328	153,788.5	2,060	1,550,894.8
3	435	171,635.5	2,074	1,478,338.2
4	451	185,873.5	2,155	1,385,146.3
5+	30,488	3,570,520.0	52,950	13,742,951.2
2+	31,702	4,081,817.5	59,239	18,157,330.5

	Combined	
Duration	Deaths	Central exposed
0	1,795	1,799,039.7
1	2,287	1,776,058.3
2	2,388	1,704,683.3
3	2,509	1,649,973.7
4	2,606	1,571,019.8
5+	83,438	17,313,471.2
2+	90,941	22,239,148.0

The variance ratios used were based on the Combined experience, and are for durations 2+ and 5+ only. When investigating the Medical and Non-medical sections two methods were used, the first with the unadjusted data, and the second with the variance ratios for the Combined data; these may strictly be too big for each section separately. The adjusted total numbers are shown below.

	Medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
5+	20,203.8	2,200,629.3	33,035.5	8,626,506.7
2+	20,645.6	2,425,793.0	35,893.6	11,014,236.8

	Combined	
Duration	Deaths	Central exposed
5+	53,239.3	10,827,136.0
2+	56,539.1	13,440,029.9

In the Paper three age ranges of interest are noted: first the extreme limits of the data; secondly the continuous range over which the exposed to risk at each age exceeds 100; thirdly the continuous range over which the deaths at each age exceed 10. Each range for each duration is noted below, except for the select durations in the Medical section in which very few ages have more than 10 deaths.

	Medical			Non-medical		
	Range	Exposed	Deaths	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10	of data	≥ 100	≥ 10
0	10–88	17–75	—	10–100	10–74	17–62
1	11–88	17–76	—	10–88	11–74	18–63
2	10–89	18–75	—	10–89	11–73	19–64
3	11–90	19–75	—	10–100	13–73	20–70
4	10–88	20–75	—	10–97	14–74	21–72
5+	10–108	21–100	29–100	10–108	15–94	22–96
2+	10–108	18–100	27–100	10–108	10–94	17–96

Duration	Range of data	Combined Exposed ≥ 100	Deaths ≥ 10
0	10–100	10–76	17–67
1	10–88	12–76	18–68
2	10–89	12–77	19–69
3	10–100	13–77	20–72
4	10–97	14–76	21–72
5+	10–108	15–100	22–100
2+	10–108	10–100	18–100

It can be seen that the Non-medical section provides the bulk of the data for the select durations, and the Medical section provides a considerable weight at the higher ages in duration 5+.

3.3 COMBINED DATA: COMPARISON OF DURATIONS

The Paper describes fully the methods used to compare the data for two different experiences in order to see whether they are significantly different, or whether they are sufficiently similar for the data to be pooled before graduating. The statistics for these tests for the Combined data are shown in Table 3.1, in which each single duration is compared with each other single duration; the comparisons of groups of consecutive durations described in the Paper are omitted.

The data for duration 5+ has been adjusted by dividing the numbers of deaths and the exposed to risk at each age by the corresponding variance ratio. For each comparison ages have been grouped so that there were at least 5 actual deaths in each age group in each experience.

As was observed in the Paper, duration 0 for the Combined data has significantly lower mortality than any other duration, and duration 5+ has significantly higher mortality than any other, but durations 1, 2, 3 and 4 are not so readily separated. There is evidence of a 'gradient' of increasing mortality with duration of selection over durations 1 to 4, but it is not very conclusive.

Although this investigation provides little justification for grouping durations 2-4 with duration 5+ to form duration 2+, as was done when the A1967-70 tables were constructed, a comparison of this duration group with the previous graduation is of interest. The following durations were therefore considered: 0, 1, 2, 3, 4, 2-4, 1-4, 2+ and 5+. This would allow select tables to be constructed:

0, 1, 2, 3, 4, 5+ (full five years selection)
0, 1, 2–4, 5+ (five years selection as A1967–70(5))
0, 1–4, 5+ (five years selection with only three groups)
0, 1, 2+ (two years selection as in A1967–70)

Each of these nine experiences was graduated using central exposures and graduating μ_x. The detailed investigations for all except duration 2+ are discussed

Table 3.1 *Male assured lives, permanent, Combined Comparison of data for different durations*

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	88·9	110·9	11	47	0·0000	13	0·0165	102·3	0·0003
0	2	87·2	112·4	14	44	0·0001	19	0·1679	141·1	0·0000
0	3	85·2	114·2	6	51	0·0000	10	0·1470	146·6	0·0000
0	4	83·3	116·0	3	53	0·0000	7	1·0000	165·0	0·0000
0	5+	68·1	101·6	1	55	0·0000	3	1·0000	385·7	0·0000
1	2	98·0	102·0	22	37	0·0337	28	0·4847	43·0	0·9417
1	3	96·0	104·0	23	34	0·0924	30	0·7142	67·7	0·1565
1	4	93·8	106·1	15	41	0·0003	24	0·6804	70·0	0·0984
1	5+	82·0	101·0	7	50	0·0000	11	0·1582	184·8	0·0000
2	3	98·0	102·0	28	31	0·3974	33	0·7904	80·9	0·0308
2	4	96·0	104·0	21	36	0·0314	31	0·8759	64·2	0·2393
2	5+	85·1	100·8	12	46	0·0000	17	0·1635	149·9	0·0000
3	4	98·2	101·8	26	32	0·2559	28	0·3753	54·1	0·6224
3	5+	87·3	100·7	12	46	0·0000	21	0·7375	126·7	0·0000
4	5+	90·0	100·6	16	41	0·0006	19	0·0719	113·1	0·0000

in the Paper. For each of the select durations a GM(2,2) formula proved to be satisfactory, no higher order being necessary. For durations 2+ and 5+ the age range for graduation was restricted to 10–90, as was done for the 1967–70 experience, and for the same reasons, as is explained in the Paper. For duration 5+ it was found in the Paper that there was a choice between a GM(2,2) and a higher order formula, and the same proved to be true for duration 2+.

Table 3.2 summarises the results for the GM(2,2) formula for each of the duration groups, and gives values of q_x and their percentage standard errors for decennial ages from 20 to 110.

3.4 COMPARISON OF GRADUATION FORMULAE

In the Paper it was discussed how, given two sets of data, to each of which had been fitted the same order of formula, the maximum likelihood estimates of the two sets of parameters could be compared by calculating the distance D between the points in the parameter space (see §13.5 of the Paper). The measure D is distributed as $\chi^2(n)$, where n is the number of parameters; the corresponding probability $p(D)$ was also calculated.

The graduated results for the seven sets of data for select durations were compared in the Paper. Five sets are independent and the other two were formed by groups of

Table 3.2. *Male assured lives, permanent. Statistics for graduations of* μ_x=GM(2,2)

Duration	0	1	2	3	4	2–4	1–4	5+	2+
Values of parameters at optimum point:									
$100\,a_0$	−0·465192	−0·713368	−0·473123	−0·394346	−0·701247	−0·487122	−0·539786	−0·378772	−0·338415
T-ratio	−3·53	−4·02	−3·91	−3·98	−3·80	−6·83	−8·14	−16·87	−19·48
$100\,a_1$	−0·452546	−0·676049	−0·474513	−0·423833	−0·687857	−0·496613	−0·540869	−0·431902	−0·386512
T-ratio	−4·40	−4·97	−4·67	−4·76	−4·51	−8·12	−9·76	−17·60	−20·96
b_0	−3·985723	−3·689744	−3·687542	−3·620979	−3·564739	−3·634119	−3·648090	−3·329023	−3·352236
T-ratio	−77·84	−73·70	−92·84	−94·56	−73·74	−161·52	−182·94	−386·74	−458·42
b_1	3·185063	3·027036	3·573205	3·989363	3·227393	3·647534	3·494553	4·595701	4·656042
T-ratio	8·21	8·88	10·87	12·73	9·56	19·54	21·51	108·49	121·59
Signs test: *p*(pos)	0·5513	0·3494	0·6506	0·5513	0·6026	0·2285	0·3561	0·6399	0·6362
Runs test: *p*(runs)	0·4491	0·2686	0·9560	0·9869	0·8544	0·6359	0·8755	0·0109	0·0642
K–S test: *p*(*KS*)	1·0000	0·9999	1·0000	1·0000	0·9993	1·0000	1·0000	0·8491	0·7696
Serial Correlation test:									
T-ratio 1	−0·67	1·29	−0·83	−1·89	−0·57	−2·59	−1·24	2·67	2·54
T-ratio 2	−0·46	0·16	−2·91	0·76	−0·40	−0·10	−0·60	1·93	2·17
T-ratio 3	0·51	−1·07	0·55	−1·46	−1·30	−0·79	−1·02	1·88	1·82
χ^2 test:									
χ^2	71·14	57·51	66·20	66·00	58·94	73·30	85·12	109·01	116·45
Degrees of freedom	56	56	56	56	55	61	62	66	70
$p(\chi^2)$	0·0837	0·4190	0·1652	0·1696	0·3336	0·1344	0·0274	0·0007	0·0004
Specimen values of q_x and percentage standard errors.									
Age 20	0·000622	0·000807	0·000695	0·000768	0·000867	0·000759	0·000775	0·000867	0·000791
percentage s.e.	22·83	20·05	14·28	10·83	21·45	6·03	4·86	4·74	3·54
Age 30	0·000424	0·000493	0·000506	0·000550	0·000543	0·000532	0·000522	0·000574	0·000554
percentage s.e.	34·19	32·75	17·20	10·04	31·96	5·18	4·46	2·66	1·95
Age 40	0·000855	0·001042	0·001109	0·001099	0·001172	0·001129	0·001106	0·001141	0·001141
percentage s.e.	18·79	17·10	9·56	6·62	16·60	3·27	2·82	1·23	1·09
Age 50	0·002476	0·003170	0·003328	0·003351	0·003614	0·003428	0·003372	0·003859	0·003813
percentage s.e.	7·03	6·07	4·27	3·57	5·98	1·92	1·66	0·63	0·60
Age 60	0·006333	0·008173	0·008830	0·009359	0·009492	0·009237	0·008998	0·011929	0·011739
percentage s.e.	4·54	3·86	3·53	3·32	3·42	1·91	1·70	0·53	0·51
Age 70	0·014382	0·018378	0·020948	0·023584	0·021825	0·022223	0·021291	0·033134	0·032718
percentage s.e.	7·19	6·03	5·87	5·58	5·48	3·25	2·86	0·59	0·58
Age 80	0·030205	0·037884	0·046198	0·055427	0·046110	0·049629	0·046602	0·085510	0·085065
percentage s.e.	11·22	9·33	9·36	8·96	8·93	5·25	4·57	0·88	0·87
Age 90	0·060190	0·073663	0·096683	0·123387	0·091894	0·105003	0·096541	0·205722	0·206478
percentage s.e.	15·73	12·98	13·18	12·56	12·76	7·44	6·45	1·29	1·25
Age 100	0·115091	0·136765	0·192489	0·258103	0·174228	0·210623	0·190101	0·442872	0·447742
percentage s.e.	20·29	16·60	16·68	15·46	16·44	9·39	8·18	1·52	1·45
Age 110	0·210921	0·242281	0·358468	0·488360	0·311969	0·392273	0·350689	0·771310	0·780129
percentage s.e.	24·18	19·59	18·69	16·00	19·07	10·42	9·27	1·21	1·11

the independent sets. The values of D and of $p(D)$ for each pair of durations or duration groups were given in the Paper, and are reproduced below.

	Value of D					
Duration	0	1	2	3	4	2–4
1	24·82	—	—	—	—	—
2	59·23	6·46	—	—	—	—
3	89·88	10·55	3·05	—	—	—
4	59·06	19·56	5·07	3·96	—	—
2–4	125·56	14·92	3·50	1·60	4·15	—
1–4	75·47	9·30	1·86	3·39	6·28	1·97

	Value of $p(D)$					
Duration	0	1	2	3	4	2–4
1	0·0001	—	—	—	—	—
2	0·0000	0·1675	—	—	—	—
3	0·0000	0·0321	0·5494	—	—	—
4	0·0000	0·0006	0·2801	0·4115	—	—
2–4	0·0000	0·0049	0·4782	0·8083	0·3856	—
1–4	0·0000	0·0540	0·7608	0·4941	0·1795	0·7418

In the Paper it was observed that duration 0 was clearly different from the others, that durations 2, 3 and 4 could be justifiably combined to form durations 2–4, but that duration 1 was significantly different from durations 2–4. Duration 5+ was clearly different from any of the select durations, and the same is true for duration 2+.

Inspection of the values of q_x for durations 0, 1, 2–4 and 5+ shows that they are reasonably 'parallel' from age 30 onwards, but that the rates for duration 1 are above those for durations 2–4 at age 20. The values of q_x cross over between ages 24 and 25. The Committee assumes that this feature should be eliminated in practical tables. There is no such overlap in the graduated rates for durations 0, 1–4 and 5+.

3.5 COMPARISON WITH GRADUATIONS OF A1967–70

The A1967–70 and A1967–70(5) tables were graduated using q_x, initial exposures, and Barnett's formula, which is equivalent to a LGM(2,2) formula. The parameters B, c, H and Y of Barnett's formula can readily be converted into the parameters, a_0, a_1, b_0 and b_1 of the LGM(2,2) formula, and the equivalent values are shown below.

Duration	0	1	2+	2–4	5+
	Barnett's formula: $q_x/p_x = B \cdot c^y - H \cdot y$ with $y = x - Y$				
Y	9·4540503	17·189620	24·794921	17·169389	24·798937
1,000B	1·4453482	0·94771326	0·70074652	1·0719874	0·76654669
c^5	1·2589772	1·3724289	1·5840485	1·3798523	1·5726555
10,000H	1·5992218	1·2295791	0·91650991	1·4344326	1·0340378

Logistic: q_x=LGM(2,2) with $t=(x-70)/50$

$100a_0$	−0·96826403	−0·64934540	−0·41430903	−0·75781951	−0·46739608
$100a_1$	−0·79961090	−0·61478955	−0·45825495	−0·71721630	−0·51701890
b_0	−3·75066287	−3·61769448	−3·10464252	−3·43619830	−3·08051774
b_1	2·30299645	3·16582090	4·59983912	3·21976464	4·52765592

The experience for the same duration groups for 1979–82 was graduated using q_x (initial exposures) and the LGM(2,2) formula. A summary of the graduations is given in Table 3.3. For the select durations they are extremely close to the μ_x=GM(2,2) ones.

For durations 5+ and 2+ there are slightly greater differences, and since the values of χ^2 are slightly lower for the q_x=LGM(2,2) graduations, there may be a case for preferring them.

The parameters of these graduations could be compared with those of the corresponding graduations in 1967–70 if the variance-covariance matrix of the parameter estimates, H^{-1}, of the earlier graduations were available. Rather than regraduate the earlier experience, using the present methods and formula, it was decided to assume that the value of the matrix was the same on that occasion; the numbers of deaths are similar, so such an assumption is justifiable. The parameters of the 1979–82 experience were found to be very significantly different from those of the 1967–70 experience.

3.6 MEDICAL AND NON-MEDICAL DATA

Table 3.4 shows a comparison of the various durations for the Medical and Non-medical data, on the same lines as Table 3.1 shows for the Combined data. In each of the sections there is a selection 'gradient' and the same durations might be grouped for each section as has been done for the combined data. There are fewer deaths in the Medical data, and duration 0 therein is less clearly distinct from the other durations than is the case for the Non-medical data. Variance ratios have not been used to adjust the duration 5+ data in this Table. Separate calculations show that the differences between duration 5+ and the lower durations would be no less significant if variance ratios had been used.

Corresponding durations and groups of durations of the Medical and Non-medical sections can be compared with each other in the same way as the different durations within each section. Table 3.5 gives the results of these tests for each single duration and for each group of consecutive durations. It can be seen that the level of mortality in the Medical section is consistently below that of the Non-medical section; that the difference is clearly non-significant only for duration 0, clearly significant for duration 5+, and fairly significant for duration 4. It is ambiguous for durations 1, 2 and 3, since one of the two out of $p(+)$ and $p(\chi^2)$ is greater than 0·05 and the other lower in each case; but when these durations are grouped, the difference becomes more clearly significant. Strictly, there is insufficient justification for combining the

Table 3.3. *Male assured lives, permanent. Statistics for graduations of* q_x = LGM(2,2)

Duration	0	1	2–4	5+	2+
Values of parameters at optimum point:					
$100\ a_0$	−0·464480	−0·710597	−0·482304	−0·339195	−0·307590
T-ratio	−3·54	−4·04	−6·82	−15·64	−18·22
$100\ a_1$	−0·448807	−0·669437	−0·488966	−0·389311	−0·353802
T-ratio	−4·40	−4·98	−8·09	−16·43	−19·77
b_0	−3·951739	−3·657380	−3·592489	−3·271841	−3·291876
T-ratio	−80·41	−77·74	−161·63	−401·08	−467·57
b_1	3·206331	3·052872	3·687205	4·744676	4·793719
T-ratio	8·24	8·93	19·61	108·81	121·43
Signs test: p(pos)	0·5513	0·3494	0·2285	0·4525	0·6362
Runs test: p(runs)	0·4491	0·2686	0·6359	0·0356	0·1470
K–S test: $p(KS)$	1·0000	0·9999	1·0000	0·6195	0·5370
Serial Correlation test:					
T-ratio 1	−0·67	1·29	−2·61	2·66	2·54
T-ratio 2	−0·46	0·16	0·07	1·94	2·19
T-ratio 3	0·52	−1·07	−0·93	1·98	1·95
χ^2 test:					
χ^2	71·16	57·50	73·69	107·41	114·95
Degrees of freedom	56	56	61	66	70
$p(\chi^2)$	0·0834	0·4196	0·1278	0·0010	0·0006
Specimen values of q_x and percentage standard errors.					
Age 20	0·000621	0·000806	0·000757	0·000830	0·000769
percentage s.e.	20·48	26·48	5·48	4·71	3·50
Age 30	0·000424	0·000493	0·000533	0·000574	0·000557
percentage s.e.	30·45	43·99	4·34	2·62	1·93
Age 40	0·000855	0·001041	0·001127	0·001144	0·001141
percentage s.e.	16·92	22·55	2·84	1·21	1·07
Age 50	0·002475	0·003170	0·003426	0·003837	0·003790
percentage s.e.	7·03	7·55	1·79	0·63	0·60
Age 60	0·006335	0·008176	0·009244	0·011930	0·011747
percentage s.e.	4·50	4·00	1·92	0·53	0·52
Age 70	0·014367	0·018351	0·022203	0·033391	0·032983
percentage s.e.	7·08	6·39	3·16	0·30	0·60
Age 80	0·030027	0·035974	0·049180	0·085771	0·085261
percentage s.e.	10·87	10·11	4·92	0·89	0·88
Age 90	0·059149	0·072103	0·101867	0·198815	0·199041
percentage s.e.	14·94	14·01	6·71	1·21	1·08
Age 100	0·110533	0·130427	0·195757	0·393211	0·395667
percentage s.e.	18·72	17·54	8·05	1·30	1·24
Age 110	0·194633	0·221320	0·340404	0·627157	0·631734
percentage s.e.	21·36	19·91	8·40	1·06	0.99

Table 3.4 *Male assured lives, permanent, Medical and Non–medical. Comparison of data for different durations*

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
						Medical				
0	1	88.9	109.5	12	15	0.3506	12	0.2351	25.9	0.5223
0	2	87.5	109.1	12	15	0.3506	13	0.3681	29.4	0.3435
0	3	77.8	114.5	7	20	0.0096	15	1.0000	48.5	0.0067
0	4	81.1	111.1	9	18	0.0610	15	0.8724	41.2	0.0390
0	5+	55.3	100.5	8	19	0.0261	10	0.1971	110.4	0.0000
1	2	98.4	101.4	16	14	0.7077	14	0.2986	19.7	0.9231
1	3	89.2	108.3	14	19	0.2434	18	0.6903	33.2	0.4558
1	4	92.8	105.0	14	20	0.1958	17	0.5027	25.4	0.8563
1	5+	67.0	100.5	7	26	0.0007	10	0.1898	99.7	0.0000
2	3	91.8	107.2	14	22	0.1215	16	0.2817	33.6	0.5842
2	4	95.2	103.8	18	20	0.4357	24	0.9345	27.2	0.9046
2	5+	70.2	100.5	10	28	0.0025	10	0.0146	73.9	0.0004
3	4	103.1	97.2	22	17	0.8316	19	0.4101	30.9	0.8177
3	5+	80.8	100.3	15	26	0.0586	12	0.0051	87.3	0.0000
4	5+	75.9	100.5	12	31	0.0027	16	0.2338	81.8	0.0003
						Non–medical				
0	1	88.8	111.2	12	43	0.0000	16	0.0932	101.9	0.0001
0	2	87.0	113.1	13	42	0.0001	20	0.4164	132.8	0.0000
0	3	86.0	114.4	4	50	0.0000	6	0.0350	132.8	0.0000
0	4	83.2	117.7	2	51	0.0000	2	0.0015	157.3	0.0000
0	5+	68.9	101.4	2	51	0.0000	5	1.0000	312.3	0.0000
1	2	97.8	102.2	21	34	0.0524	22	0.0988	50.3	0.6551
1	3	96.6	103.5	24	30	0.2483	26	0.3730	83.4	0.0063
1	4	93.6	106.8	11	42	0.0000	18	0.4662	72.9	0.0361
1	5+	83.4	100.8	7	46	0.0000	13	0.5999	154.5	0.0000
2	3	98.8	101.2	26	29	0.3939	33	0.9174	104.3	0.0001
2	4	95.8	104.4	20	34	0.0380	27	0.6513	68.9	0.0828
2	5+	87.2	100.6	12	43	0.0000	19	0.4634	119.5	0.0000
3	4	97.1	103.0	24	31	0.2094	26	0.3336	56.8	0.4089
3	5+	88.2	100.5	15	41	0.0003	27	0.9532	114.9	0.0000
4	5+	93.2	100.3	21	33	0.0668	27	0.5951	78.1	0.0177

Table 3.5 *Male assured lives, permanent, Medical and Non–medical; Comparison of data for same durations Medical (I) versus Non–medical (II)*

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	92.4	101.0	13	15	0.4253	12	0.1753	32.4	0.2600
1	88.7	101.8	14	20	0.1958	16	0.3630	57.1	0.0079
2	85.2	102.8	13	26	0.0266	20	0.7774	52.6	0.0721
3	93.3	101.5	18	23	0.2664	15	0.0330	84.9	0.0001
4	86.6	103.4	15	28	0.0330	19	0.3631	60.0	0.0437
5+	95.4	102.9	21	49	0.0005	20	0.0026	251.6	0.0000
0–1	91.1	101.3	21	27	0.2354	26	0.7104	66.1	0.0425
1–2	86.8	102.3	21	29	0.1611	27	0.7346	87.0	0.0009
2–3	89.9	102.1	19	33	0.0352	21	0.1387	94.8	0.0003
3–4	89.7	102.5	23	29	0.2442	20	0.0401	119.3	0.0000
4+	95.3	102.9	22	51	0.0005	21	0.0025	268.7	0.0000
0–2	88.9	101.8	21	34	0.0524	25	0.3368	93.6	0.0009
1–3	89.8	102.0	21	33	0.0668	23	0.1806	122.9	0.0000
2–4	88.7	102.5	21	33	0.0668	23	0.1806	123.3	0.0000
3+	95.3	102.8	27	47	0.0133	24	0.0032	281.3	0.0000
0–3	91.0	101.6	25	31	0.2522	19	0.0058	118.9	0.0000
1–4	88.9	102.3	22	34	0.0704	17	0.0019	146.7	0.0000
2+	95.3	102.7	27	48	0.0101	24	0.0027	285.5	0.0000
0–4	90.2	101.9	22	36	0.0435	18	0.0029	143.6	0.0000
1+	95.3	102.6	28	48	0.0143	24	0.0016	289.2	0.0000
0+	95.5	102.5	32	44	0.1034	19	0.0000	281.1	0.0000

two sections and graduating the combined data, but this has always been done by the Committee.

Each of the nine durations and duration groups which were investigated for the Combined data have been graduated for the Medical and Non-medical sections, using in each case the formula μ_x=GM(2,2). In each case the graduated formula fits the data at least as well as for the Combined data. Summaries are given in Tables 3.6 and 3.7.

For durations 5+ and 2+ the variance ratios appropriate to the combined data were used. The resulting graduated parameters and values of q_x are very close to those produced when variance ratios were not used. The use of variance ratios reduces the values of χ^2 and of the T-ratios of the serial correlation coefficients, so giving the impression that the formula fits better. At the same time the T-ratios of the parameter estimates and the standard errors of the estimates of q_x are increased, which reflects the greater uncertainty about where the graduated rates lie.

The graduated rates for the Medical section do not increase uniformly with

Table 3.6. *Male assured lives, permanent, Medical. Statistics for graduations of* μ_x=GM(2,2)

Duration	0	1	2	3	4	2–4	1–4	5+	2+
Values of parameters at optimum point:									
$100\ a_0$	−0·009032	−0·144555	−0·054025	0·034315	−0·248798	−0·079629	−0·110914	−0·179225	−0·162991
T-ratio	−0·06	−0·62	−0·32	0·17	−0·88	−0·65	−0·99	−4·28	−4·57
$100\ a_1$	−0·058635	−0·183906	−0·086585	0·021381	−0·277586	−0·105898	−0·021381	−0·211202	−0·201145
T-ratio	−0·35	−0·81	−0·50	0·10	−1·02	−0·86	−1·27	−4·17	−4·75
b_0	−4·422133	−4·097913	−4·029283	−4·106276	−3·906656	−4·102495	−4·020442	−3·446255	−3·465745
T-ratio	−25·91	−28·04	−34·15	−30·39	−29·88	−55·98	−62·32	−182·98	−204·40
b_1	4·750555	4·108918	4·668901	4·310043	3·891851	4·291176	4·195602	4·950435	5·005030
T-ratio	3·86	4·16	5·36	4·54	4·61	8·44	9·33	66·86	72·25
Signs test: p(pos)	0·7077	0·2498	0·8317	0·1510	0·7693	0·5531	0·7441	0·6460	0·4036
Runs test: p(runs)	0·9081	0·8806	0·6671	0·8364	0·6913	0·9605	0·4608	0·1903	0·4084
K–S test: $p(KS)$	1·0000	0·9905	1·0000	0·9903	0·9998	0·9873	0·9284	0·6940	0·6150
Serial Correlation test:									
T-ratio 1	−1·95	0·33	−0·47	−0·35	−0·21	−0·76	0·27	3·23	2·71
T-ratio 2	−0·56	0·75	−0·97	1·06	−1·02	−0·19	−0·10	2·43	2·67
T-ratio 3	0·27	−0·35	0·06	−0·12	1·36	1·17	1·32	2·02	2·23
χ^2 test:									
χ^2	34·96	47·24	34·04	54·07	42·60	67·91	92·94	69·63	77·73
Degrees of freedom	26	31	35	42	42	52	54	60	63
$p(\chi^2)$	0·1124	0·0310	0·5143	0·1003	0·4454	0·0683	0·0008	0·1850	0·1002
Specimen values of q_x and percentage standard errors:									
Age 20	0·000599	0·000659	0·000492	0·000362	0·000687	0·000511	0·000563	0·000536	0·000582
percentage s.e.	130·19	227·63	90·25	136·82	141·61	37·94	28·92	21·68	15·64
Age 30	0·000654	0·000654	0·000589	0·000721	0·000634	0·000650	0·000653	0·000514	0·000559
percentage s.e.	118·63	219·06	66·24	95·14	147·81	20·59	16·98	9·86	7·16
Age 40	0·000984	0·001110	0·001102	0·001511	0·001173	0·001266	0·001229	0·001171	0·001188
percentage s.e.	80·34	123·62	40·32	47·78	81·26	12·72	10·96	2·95	2·75
Age 50	0·002020	0·002614	0·002674	0·003322	0·002999	0·003006	0·002929	0·003649	0·003587
percentage s.e.	39·48	48·03	19·91	22·63	31·19	7·32	6·39	1·43	1·37
Age 60	0·004881	0·006492	0·006928	0·007358	0·007612	0·007384	0·007220	0·010993	0·010773
percentage s.e.	16·57	16·11	9·94	10·21	11·00	4·60	4·11	0·98	0·96
Age 70	0·012424	0·015720	0·017932	0·017392	0·018227	0·017918	0·017442	0·031186	0·030735
percentage s.e.	15·38	12·94	11·46	11·12	10·27	6·23	5·58	0·85	0·83
Age 80	0·031846	0·036842	0·045636	0·040282	0·041582	0·042602	0·041052	0·084163	0·083672
percentage s.e.	28·60	24·02	20·71	21·06	18·93	11·57	10·34	1·04	1·04
Age 90	0·080490	0·083643	0·112882	0·092325	0·091137	0·098661	0·093876	0·213359	0·214076
percentage s.e.	46·75	38·49	32·13	33·79	29·55	18·08	16·16	1·68	1·65
Age 100	0·195399	0·182182	0·263567	0·204538	0·190907	0·218466	0·205528	0·477945	0·482787
percentage s.e.	62·12	52·46	40·68	45·30	39·71	23·88	21·46	2·11	2·03
Age 110	0·430394	0·368939	0·541508	0·417979	0·372331	0·441909	0·414201	0·826954	0·834450
percentage s.e.	56·12	54·69	36·91	46·13	43·44	23·65	23·65	1·54	1·43

Table 3.7. *Male assureds, permanent, Non−medical. Statistics for graduations of* μ_x=GM(2,2)

Duration	0	1	2	3	4	2–4	1–4	5+	2+
Values of parameters at optimum point:									
$100\,a_0$	−0·436552	−0·624577	−0·436528	−0·300535	−0·574404	−0·400128	−0·451948	−0·344218	−0·365058
T-ratio	−3·44	−3·94	−3·73	−3·82	−3·69	−6·55	−7·87	−12·74	−16·60
$100\,a_1$	−0·435287	−0·615070	−0·450125	−0·350260	−0·587836	−0·430976	−0·475988	−0·404450	−0·415850
T-ratio	−4·30	−4·86	−4·47	−4·67	−4·37	−7·85	−9·48	−13·87	−18·35
b_0	−3·931545	−3·646733	−3·608862	−3·481642	−3·488713	−3·533965	−3·564168	−3·251012	−3·300952
T-ratio	−81·07	−85·50	−82·76	−70·03	−84·08	−136·05	−164·36	−337·96	−385·96
b_1	3·399453	3·333501	3·835612	4·526953	3·702217	4·124024	3·924949	4·868683	4·680167
T-ratio	7·94	8·84	10·45	13·71	9·88	20·00	21·82	72·25	82·43
Signs test: p(pos)	0·5000	0·0924	0·8554	0·2135	0·7050	0·3073	0·4503	0·6399	0·2807
Runs test: p(runs)	0·6070	0·6156	0·7447	0·8857	0·4003	0·3231	0·6508	0·0356	0·4754
K−S test: $p(KS)$	1·0000	0·9919	1·0000	0·9878	0·9999	0·9999	0·9987	0·9881	0·9526
Serial Correlation test:									
T-ratio 1	−0·10	0·21	−1·42	−1·05	−0·32	−1·58	−0·91	1·51	1·86
T-ratio 2	−0·38	−0·26	−2·85	0·24	−0·45	0·68	−0·30	0·89	1·85
T-ratio 3	−0·16	−0·60	0·85	−1·22	−2·46	−1·65	−1·67	0·32	0·61
χ^2 test:									
χ^2	56·79	59·53	71·69	77·39	60·24	72·95	78·39	77·57	87·66
Degrees of freedom	53	53	53	53	51	59	60	66	70
$p(\chi^2)$	0·3359	0·2501	0·0445	0·0161	0·1763	0·1047	0·0557	0·1561	0·0752
Specimen values of q_x and percentage standard errors.									
Age 20	0·000621	0·000805	0·000698	0·000769	0·000857	0·000757	0·000774	0·000873	0·000824
percentage s.e.	22·01	17·14	14·04	9·64	17·19	5·72	4·61	5·21	3·71
Age 30	0·000411	0·000487	0·000499	0·000541	0·000539	0·000526	0·000516	0·000580	0·000548
percentage s.e.	33·99	27·82	17·09	7·34	23·53	4·35	3·82	2·75	2·04
Age 40	0·000842	0·001032	0·001108	0·001037	0·001162	0·001103	0·001084	0·001134	0·001132
percentage s.e.	18·52	14·88	9·59	5·55	12·88	2·99	2·61	1·36	1·19
Age 50	0·002539	0·003255	0·003454	0·003367	0·003751	0·003519	0·003460	0·003915	0·003905
percentage s.e.	6·72	5·38	4·31	3·54	4·95	1·97	1·71	0·72	0·71
Age 60	0·006722	0·008728	0·009515	0·010317	0·010435	0·010103	0·009775	0·012454	0·012213
percentage s.e.	5·04	4·31	4·08	3·90	3·88	2·26	1·99	0·69	0·66
Age 70	0·015671	0·020466	0·023459	0·028771	0·025564	0·026037	0·024587	0·035230	0·034332
percentage s.e.	8·46	7·18	7·10	6·79	6·81	3·99	3·49	0·98	0·93
Age 80	0·034179	0·043988	0·053807	0·075034	0·057756	0·062473	0·057362	0·089471	0·089691
percentage s.e.	13·10	11·01	11·20	10·71	10·92	6·35	5·50	1·54	1·48
Age 90	0·070313	0·089295	0·116918	0·183591	0·122977	0·141527	0·126405	0·196517	0·217914
percentage s.e.	18·19	15·15	15·52	14·46	15·26	8·77	7·61	1·91	2·07
Age 100	0·138442	0·172436	0·239692	0·405776	0·246423	0·298600	0·261430	0·348364	0·469639
percentage s.e.	23·16	19·02	19·09	16·17	18·88	10·53	9·29	1·74	2·31
Age 110	0·259230	0·314018	0·449785	0·734759	0·452456	0·558159	0·489456	0·486123	0·803259
percentage s.e.	26·83	21·59	20·07	12·92	20·00	10·36	9·62	1·17	1·66

duration; indeed their 'tails' are rather higgledy-piggledy. This reflects the rather small number of deaths in the select durations. For these durations the r-parameters are often not significantly different from zero, which indicates that a GM(1,2) or GM(0,2) formula might fit the data just as well.

The graduated rates for the Non-medical section are generally higher than those for the Medical section, though not everywhere. In particular the rates are lower where the 'tails' of the graduations for the Medical section wave about. The test described above for comparing the parameters of a graduated formula has been used again, first to compare the Medical and Non-medical durations among themselves, and secondly to compare the parameters of the graduated rates for corresponding durations of Medical versus Non-medical. The values of $p(D)$ for the former tests are shown below.

	Value of $p(D)$					
			Medical			
Duration	0	1	2	3	4	2–4
1	0·4364	—	—	—	—	—
2	0·1099	0·8948	—	—	—	—
3	0·0147	0·1453	0·2092	—	—	—
4	0·0346	0·6855	0·9126	0·7757	—	—
2–4	0·0171	0·4112	0·8313	0·5993	0·9696	—
1–4	0·0327	0·6381	0·9387	0·4080	0·9369	0·9777
			Non-medical			
1	0·0002	—	—	—	—	—
2	0·0000	0·1878	—	—	—	—
3	0·0000	0·0177	0·1886	—	—	—
4	0·0000	0·0013	0·2281	0·1900	—	—
2–4	0·0000	0·0048	0·5964	0·5119	0·3451	
1–4	0·0000	0·0570	0·6695	0·2495	0·1279	0·7340

In each case, when any select duration is compared with duration 5+ or 2+ the value of $p(D)$ is almost zero, indicating that the parameters of the graduations of the 'ultimate' durations are significantly different from those of any of the select durations. It can be seen from these tables that the parameters of the graduated rates for the different select durations for the Medical section are not different from one another, but that for the durations in the Non-medical section the same differentiations can be made as for the Combined data. The Non-medical section forms such a large fraction of the Combined data that it cannot show very different results in any respect.

The values of D and of $p(D)$ when corresponding durations of the two sections are compared are shown below. Note that D is to be compared with $\chi^2(4)$

Duration	D	$p(D)$
0	12·23	0·0157
1	13·58	0·0876
2	15·72	0·0034
3	30·53	0·0000
4	20·37	0·0004
2–4	59·52	0·0000
1–4	71·22	0·0000
2+	89·82	0·0000
5+	107·22	0·0000

This confirms that the parameters of the graduated rates for the corresponding durations of the Medical and Non-medical sections are significantly different, in general extremely so.

3.7 QUESTIONS FOR THE PROFESSION

In section 1.2 the Committee raised a number of questions for the profession that apply to each investigation, and each one of them applies to this one. In addition the Committee would like to know the profession's view on a number of topics specific to this investigation.

(1) If a standard table is desired, which select period should be used? A two year select period, as in A1967–70, would conform with current usage. A five year period, with durations 2 to 4 combined, is justified by the data, and matches what was done for A1967–70(5). Should both be produced, as for A1967–70?

(2) The Committee expects that the high values of the rates for duration 1 for low ages would be adjusted so that the values of q_x for a particular age x rise with duration. Is such an adjustment thought to be essential, desirable, or unimportant?

(3) Is there any demand for separate tables for the Medical and Non-medical sections?

4. TEMPORARY ASSURANCES, MALES

4.1 INTRODUCTION

Two investigations into the mortality experience of male lives assured for temporary assurances have been carried out, one for level temporary assurances and the other for decreasing temporary assurances. Although the experience has been collected since 1971 and reported on at quadrennial intervals, the Committee has not previously attempted to prepare graduated tables based on these experiences.

Each experience is on the same lines as that for permanent assurances, being subdivided into Medical and Non-medical sections, and with five years of select durations and one 'ultimate' duration, 5+. The numbers of deaths and the central exposed to risk for each section and for each duration for each investigation are shown below.

	Level Temporary		Decreasing Temporary	
	Medical		Medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	70	50,372·5	66	32,904·5
1	65	45,053·0	73	36,744·5
2	63	36,484·5	90	38,414·5
3	61	30,114·5	107	40,256·5
4	53	26,254·5	91	40,570·5
5+	192	89,976·5	1,313	370,017·0
	Non-medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	194	214,648·0	177	232,155·0
1	162	162,505·0	239	228,834·0
2	128	124,898·0	260	230,003·0
3	134	101,094·5	301	234,479·0
4	87	84,769·0	266	219,179·0
5+	305	241,981·5	3,158	1,336,850·5
	Combined		Combined	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	264	265,020·5	243	265,059·5
1	227	207,558·0	312	265,578·5
2	191	161,382·5	350	268,417·5
3	195	131,209·0	408	274,735·5
4	140	111,023·5	357	259,749·5
5+	497	331,958·0	4,471	1,706,867·5

The relevant age ranges are shown below. In most cases the numbers of deaths were too few to provide a reasonable continuous range with more than 10 deaths at each age

	Level Temporary			Decreasing Temporary		
		Medical			Medical	
	Range	Exposed	Deaths	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10	of data	≥ 100	≥ 10
0	10–86	21–66	—	16–90	21–65	—
1	11–82	22–67	—	17–91	22–66	—
2	12–82	23–64	—	18–80	23–65	—
3	13–83	24–65	—	19–81	24–66	—
4	10–84	25–64	—	20–82	25–66	—
5+	10–85	26–68	—	10-100	26–72	35–71
		Non-medical			Non-medical	
	Range	Exposed	Deaths	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10	of data	≥ 100	≥ 10
0	10–90	17–61	—	10–73	19–61	—
1	10–91	18–61	—	10–76	20–62	—
2	11–80	19–62	—	11–77	21–62	—
3	12–76	21–61	—	10–79	22–63	—
4	13–76	22–60	—	10–77	23–63	—
5+	10–78	23–64	51–55	10–80	24–68	29–66
		Combined			Combined	
	Range	Exposed	Deaths	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10	of data	≥ 100	≥ 10
0	10–90	17–66	—	10–90	19–65	—
1	10–91	18–67	—	10–91	20–66	—
2	11–82	19–65	—	11–80	21–66	—
3	12–83	20–65	—	10–81	22–66	—
4	10–84	22–65	—	10–82	23–66	—
5+	10–85	22–68	38–64	10-100	24–73	29–71

Each investigation is much smaller than that for permanent assurances, and the relative weight of the 5+ data is much less than in that investigation. This is particularly the case for level temporary assurances; it may be assumed that duration '5+' in this case represents something like durations '5 to 8'. The age range does not extend substantially beyond about 70.

The numbers of deaths in the combined medical and non-medical experiences are sufficiently large to make graduation worth while, but even so the numbers in the select durations are on the small side. It was therefore apppropriate to investigate, first, whether the experiences were significantly different from that for permanent assurances, and secondly, whether the experiences for level temporary and decreasing temporary assurances were sufficiently similar for them to be amalgamated.

4.2 COMPARISON WITH PERMANENT ASSURANCES

Tables 4.1 and 4.2 show comparisons of the experiences for level temporary and decreasing temporary respectively with that for permanent assurances, comparing each duration and each group of neighbouring durations. Level temporary assurances have lighter mortality than permanent assurances for all durations except duration 0, where the levels of mortality are about the same. Duration 3 is not significantly different, but all the other durations are on the basis of $p(+)$.

Decreasing temporary assurances also have lighter mortality than permanent assurances, except at duration 3, where the levels of mortality are not significantly different. At duration 2 the level is lower, but not significantly so, and at duration 5+ the difference is marginal. It would not be justifiable to claim that either experience was so similar to that for permanent assurances that further investigation was unnecessary.

Table 4.1

Male assured lives. Comparison of data for same durations
Permanent (I) versus Level Temporary (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	99·8	101·3	14	21	0·1553	22	0·9546	33·5	0·5412
1	101·6	86·3	22	7	0·9988	12	0·6343	13·7	0·9927
2	101·5	84·6	20	7	0·9970	9	0·1751	21·9	0·7414
3	100·3	95·8	14	14	0·5747	15	0·5734	27·1	0·5103
4	101·6	77·5	16	5	0·9964	8	0·4276	25·6	0·2204
5+	100·3	76·1	29	11	0·9989	12	0·0381	81·7	0·0001
0–1	100·9	93·0	27	17	0·9519	26	0·9324	40·1	0·6400
1–2	101·6	85·4	33	9	1·0000	14	0·3453	47·1	0·2734
2–3	100·8	90·4	26	12	0·9931	22	0·9755	31·8	0·7509
3–4	100·9	87·6	25	10	0·9970	17	0·8349	40·3	0·2479
4+	100·4	75·8	33	9	1·0000	13	0·2314	96·2	0·0000
0–2	101·2	89·7	33	15	0·9972	20	0·3406	54·2	0·2505
1–3	101·1	88·5	32	11	0·9997	20	0·8892	45·2	0·3808
2–4	101·1	86·6	31	9	0·9999	18	0·9477	56·1	0·0468
3+	100·4	78·6	34	8	1·0000	11	0·1203	97·0	0·0000
0–3	101·0	90·4	33	16	0·9953	18	0·0912	53·6	0·3032
1–4	101·3	86·1	35	10	1·0000	16	0·4498	56·4	0·1186
2+	100·5	78·1	38	7	1·0000	10	0·0856	125·1	0·0000
0–4	101·2	87·8	39	10	1·0000	12	0·0276	64·8	0·0645
1+	100·6	77·4	39	7	1·0000	10	0·0807	142·9	0·0000
0+	100·7	77·4	41	9	1·0000	10	0·0080	176·2	0·0000

Table 4.2

Male assured lives. Comparison of data for same durations Permanent (I) versus Decreasing Temporary (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	101·6	89·5	23	8	0·9983	15	0·9162	16·8	0·9822
1	101·6	89·8	25	12	0·9900	17	0·5437	33·0	0·6588
2	101·0	93·7	21	14	0·9123	15	0·2053	24·9	0·8961
3	99·8	101·2	17	20	0·3714	23	0·9168	36·8	0·4779
4	101·6	89·8	26	9	0·9991	17	0·9404	26·7	0·8433
5+	100·2	97·5	29	19	0·9443	25	0·6808	33·0	0·9516
0–1	101·6	89·9	30	13	0·9973	21	0·8133	38·9	0·6488
1–2	101·2	92·3	26	17	0·9369	21	0·4918	40·3	0·5900
2–3	100·3	98·1	20	22	0·4388	23	0·6845	49·4	0·2005
3–4	100·6	95·9	26	17	0·9369	20	0·3642	38·9	0·6517
4+	100·3	96·7	33	16	0·9953	25	0·8388	40·4	0·8037
0–2	101·3	91·7	30	15	0·9920	22	0·6846	47·0	0·3913
1–3	100·7	95·7	25	20	0·8144	17	0·0396	49·7	0·2916
2–4	100·7	95·4	28	17	0·9638	21	0·4165	50·8	0·2545
3+	100·3	96·9	36	15	0·9991	21	0·4109	42·1	0·8089
0–3	100·8	94·7	28	19	0·9281	24	0·6015	52·6	0·2650
1–4	100·9	94·4	32	15	0·9960	16	0·0477	50·2	0·3473
2+	100·3	96·5	39	14	0·9999	25	0·9318	47·8	0·6771
0–4	101·0	93·6	32	16	0·9934	21	0·3931	56·2	0·1953
1+	100·4	96·0	42	12	1·0000	21	0·7821	55·4	0·4231
0+	100·5	95·4	42	13	1·0000	22	0·7043	60·0	0·2982

4.3 COMPARISON OF LEVEL TEMPORARY AND DECREASING TEMPORARY

Table 4.3 shows the same comparisons for level temporary versus decreasing temporary assurances. Generally level temporary assurances show lower mortality than decreasing. The exception is at duration 0, where the difference is not significant.

At the other select durations the differences are not significant, even when durations 1 to 4 are combined. At duration 5+ the experience of level temporary is significantly lower than that of decreasing temporary. This might be because the effective duration of 5+ for the level temporaries is fairly low, and the effect of selection persists into it.

For each investigation separately and for the two combined each single duration was compared with each other single duration and each group of consecutive durations was compared with each neighbouring group. The results for the comparison of each single duration are shown in Tables 4.4, 4.5 and 4.6.

Table 4.3
Male assured lives. Comparison of data for same durations
Level Temporary (I) versus Decreasing Temporary (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	107·5	93·0	18	11	0·9320	18	0·9395	18·2	0·9405
1	97·1	102·3	13	16	0·3555	15	0·5212	13·5	0·9935
2	92·8	104·4	10	15	0·2122	17	0·9755	29·4	0·2486
3	96·6	101·7	13	14	0·5000	15	0·6525	25·3	0·5579
4	90·8	104·1	9	12	0·3318	11	0·5350	18·8	0·6006
5+	81·6	102·6	11	29	0·0032	14	0·1565	68·8	0·0031
0–1	102·0	98·3	23	19	0·7796	24	0·8022	21·6	0·9961
1–2	94·8	103·6	16	24	0·1341	17	0·1838	35·7	0·6643
2–3	94·1	103·3	15	23	0·1279	20	0·6747	36·7	0·5274
3–4	94·3	102·7	15	20	0·2498	19	0·6813	31·8	0·6240
4+	81·3	103·1	10	32	0·0005	12	0·0546	81·7	0·0002
0–2	98·4	101·2	20	24	0·3258	25	0·7945	26·9	0·9801
1–3	94·6	103·4	17	25	0·1400	18	0·1871	40·1	0·5535
2–4	93·3	103·5	13	27	0·0192	18	0·4803	39·9	0·4741
3+	84·1	103·1	10	32	0·0005	13	0·1273	75·5	0·0011
0–3	96·8	102·2	19	28	0·1215	22	0·3622	35·4	0·8917
1–4	93·8	103·6	17	27	0·0871	20	0·3280	40·2	0·6344
2+	84·1	103·6	12	33	0·0012	16	0·1991	89·4	0·0001
0–4	95·7	102·8	19	28	0·1215	20	0·1681	34·7	0·9074
1+	84·3	104·1	10	35	0·0001	14	0·1716	98·6	0·0000
0+	84·8	104·6	12	36	0·0004	12	0·0069	108·9	0·0000

For level temporary assurances there is some evidence of a selection 'gradient', in that duration 0 is a little lower than duration 1, duration 1 than duration 2, duration 2 than duration 4 and duration 4 than duration 5+. Duration 3, however, breaks the sequence, showing the highest level of mortality of any duration. Duration 3 is significantly higher than durations 4 and 5+ according to the signs test (the values of $p(+)$ are greater than 0·99), but not according to the χ^2 test.

For decreasing temporary assurances there is also a selection gradient, with duration 3 again out of line as compared with duration 4, but this time not significantly so. Duration 0 is significantly low, and duration 5+ is significantly higher than durations 0, 1 and 2, though not much different from durations 3 and 4.

When the experiences are combined these last remarks are reinforced. Duration 0 is clearly lower than the others (though the difference from duration 1 is marginal), and duration 5+ is clearly higher. Durations 2, 3 and 4 are not significantly different, and the only doubt is whether duration 1 should be grouped with them.

Table 4.4

Male assured lives, level temporary. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	97·9	102·6	14	15	0·5000	19	0·9358	15·9	0·9765
0	2	96·7	104·9	9	16	0·1148	13	0·6675	20·2	0·7373
0	3	90·5	116·6	9	18	0·0610	10	0·1336	30·5	0·2907
0	4	96·9	106·3	7	13	0·1316	9	0·3785	16·5	0·6830
0	5+	89·7	106·5	11	20	0·0748	13	0·2500	40·4	0·1195
1	2	98·6	101·8	12	12	0·5806	13	0·5789	16·1	0·8855
1	3	91·3	112·5	8	17	0·0539	11	0·4285	17·3	0·8712
1	4	98·8	102·0	9	11	0·4119	11	0·6050	13·1	0·8714
1	5+	92·0	104·1	10	17	0·1239	15	0·7904	20·3	0·8198
2	3	91·3	110·3	7	15	0·0669	9	0·2990	27·3	0·2003
2	4	99·9	100·1	8	11	0·3238	10	0·5467	10·6	0·9361
2	5+	93·6	102·7	10	16	0·1635	14	0·6886	14·4	0·9673
3	4	108·9	89·8	14	5	0·9904	9	0·7663	19·7	0·4099
3	5+	107·9	97·2	20	8	0·9937	11	0·3322	35·7	0·1502
4	5+	92·4	102·4	7	14	0·0946	12	0·8561	12·2	0·9338

Table 4.5

Male assured lives, decreasing temporary. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	88·0	111·9	7	22	0·0041	13	0·8560	23·0	0·7771
0	2	83·4	116·1	4	24	0·0001	8	0·5675	31·0	0·3151
0	3	77·6	120·7	2	25	0·0000	4	0·2137	47·9	0·0079
0	4	82·6	116·8	4	24	0·0001	9	1·0000	31·8	0·2834
0	5+	63·5	103·2	1	26	0·0000	3	1·0000	73·0	0·0000
1	2	95·5	104·4	17	16	0·6358	23	0·9840	30·5	0·5902
1	3	89·7	109·6	10	23	0·0175	14	0·4109	37·6	0·2661
1	4	95·2	104·6	14	20	0·1958	19	0·7667	31·8	0·5752
1	5+	78·8	101·9	8	27	0·0009	15	0·8777	47·6	0·0764
2	3	94·2	105·6	12	22	0·0607	23	0·9982	32·5	0·5435
2	4	99·6	100·4	16	16	0·5700	19	0·8138	24·1	0·8423
2	5+	85·4	101·4	10	24	0·0122	15	0·5656	38·3	0·2802
3	4	105·5	94·4	20	13	0·9186	16	0·4592	34·9	0·3785
3	5+	94·9	100·5	16	20	0·3089	15	0·1300	45·1	0·1425
4	5+	85·8	101·3	14	21	0·1553	11	0·0118	47·2	0·0811

Table 4.6
Male assureds, level and decreasing temporary combined. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	93·0	107·7	14	26	0·0403	20	0·6681	31·7	0·8240
0	2	89·6	112·2	7	32	0·0000	13	0·7333	50·8	0·0973
0	3	83·6	119·8	4	33	0·0000	8	0·4555	81·7	0·0000
0	4	89·2	114·1	9	28	0·0013	15	0·6625	40·9	0·3045
0	5+	70·1	104·6	4	32	0·0000	8	0·4658	119·7	0·0000
1	2	96·5	103·8	16	23	0·1684	19	0·4494	39·8	0·4342
1	3	89·9	111·2	10	29	0·0017	12	0·0751	52·1	0·0778
1	4	95·9	104·8	15	25	0·0769	23	0·9033	31·6	0·8253
1	5+	79·2	102·9	4	35	0·0000	9	1·0000	63·7	0·0075
2	3	92·9	107·4	14	25	0·0541	18	0·4306	40·0	0·4242
2	4	99·1	101·0	18	21	0·3746	23	0·8447	23·4	0·9773
2	5+	83·9	102·1	7	32	0·0000	13	0·7333	52·5	0·0730
3	4	106·5	93·1	23	16	0·9002	22	0·8098	37·9	0·5221
3	5+	95·7	100·6	19	21	0·4373	13	0·0077	51·6	0·1038
4	5+	84·1	101·9	12	28	0·0083	10	0·0030	51·6	0·1033

4.4 GRADUATION OF COMBINED EXPERIENCES

The experiences of durations 0, 1, 2–4, 1–4 and 5+ for the combined temporary data were graduated, using μ_x=GM(r,s). In every case a formula of order (2,2) proved to be the most suitable. Lower order formulae had a considerably lower value of the L_I criterion, and higher order formulae showed only a slight improvement. The GM(2,2) formula in every case was a very satisfactory fit, and the only adverse feature was that the r-parameters for durations 0 and 1 were not significantly different from zero, and (for the same reason) the standard errors of the estimates of q_x were very large.

Summaries of the μ_x=GM(2,2) graduations are shown in Table 4.7. The parameter estimates for the different duration groups were compared with each other by comparing the distance D in the parameter space, with the results shown below.

	Value of D			
Duration	0	1	2–4	1–4
1	37·04	—	—	—
2–4	88·81	8·86	—	—
1–4	131·37	5·24	1·21	—
5+	168·70	58·06	57·20	92·10

Table 4.7

Male assured lives, temporary combined. Statistics for graduations of μ_x=GM(2,2)

Duration	0	1	2–4	1–4	5+
Values of parameters at optimum point:					
100 a_0	−8·935660	−0·654660	−0·615477	−0·616370	−0·620970
T-ratio	−0·29	−1·14	−1·93	−2·29	−3·62
100 a_1	−3·775563	−0·599192	−0·576934	−0·576586	−0·676328
T-ratio	−0·47	−1·40	−2·25	−2·71	−4·04
b_0	−2·318362	−3·882168	−3·734363	−3·773543	−3·340552
T-ratio	−0·75	−20·11	−43·09	−49·43	−103·57
b_1	0·628717	2·792900	3·105004	3·048161	4·051857
T-ratio	0·52	2·57	4·89	5·64	11·40
Signs test: *p*(pos)	0·2257	0·6196	0·5573	0·5561	0·8042
Runs test: *p*(runs)	0·9679	0·3789	0·1528	0·0985	0·6429
K–S test: *p*(*KS*)	0·9986	1·0000	0·9907	0·9613	1·0000
Serial Correlation test:					
T-ratio 1	−0·82	−0·09	0·72	0·45	0·55
T-ratio 2	1·21	0·73	−1·32	−0·59	0·38
T-ratio 3	0·51	−0·06	−2·44	−1·64	1·50
χ^2 test:					
χ^2	38·54	31·39	45·53	47·96	35·05
Degrees of freedom	40	39	44	46	45
$p(\chi^2)$	0·5362	0·8020	0·4083	0·3932	0·8567
Specimen values of q_x and percentage standard errors.					
Age 20	0·000845	0·000683	0·000661	0·000668	0·001127
percentage s.e.	8240·81	299·29	64·92	43·81	16·91
Age 30	0·000373	0·000456	0·000459	0·000459	0·000576
percentage s.e.	17926·72	418·32	97·14	66·87	15·62
Age 40	0·000847	0·000955	0·001074	0·001041	0·001024
percentage s.e.	7512·10	181·44	44·04	31·82	10·50
Age 50	0·002396	0·002721	0·003208	0·003078	0·003717
percentage s.e.	2516·87	52·50	13·88	10·35	3·61
Age 60	0·005155	0·006692	0·008153	0·007776	0·011415
percentage s.e.	1099·04	16·03	5·85	4·89	2·27
Age 70	0·009279	0·014480	0·018264	0·017312	0·030151
percentage s.e.	568·39	16·47	9·47	8·12	4·70
Age 80	0·014931	0·028820	0·037763	0·035553	0·072563
percentage s.e.	324·98	26·46	16·11	13·66	8·69
Age 90	0·022291	0·054238	0·073940	0·069133	0·162701
percentage s.e.	197·45	39·40	24·07	20·21	12·98
Age 100	0·031552	0·097895	0·138534	0·128733	0·335808
percentage s.e.	124·41	55·50	32·54	27·16	16·00
Age 110	0·042916	0·170175	0·247725	0·229339	0·606118
percentage s.e.	80·06	69·86	38·87	32·86	15·02

	Value of $p(D)$			
Duration	0	1	2–4	1–4
1	0·0000	—	—	—
2–4	0·0000	0·0648	—	—
1–4	0·0000	0·2633	0·8771	—
5+	0·0000	0·0000	0·0000	0·0000

Durations 0 and 5+ stand out as different from the others. Duration 1 is hardly significantly different from durations 2–4. It would be reasonable to group it with durations 2–4, and use the sequence of durations: 0, 1–4, 5+, in a standard table.

Although the values of q_x in the central part of the age range bear the expected relationships to one another, i.e. increasing as duration increases for the same age, the 'tails' of the graduations cross over in some cases. This feature would need to be eliminated in any published standard table.

4.5 QUESTIONS FOR THE PROFESSION

It is clear that the temporary assurance experience is lower than that of permanent assurances. There is no significant difference between the experiences of level temporary and of decreasing temporary assurances (except at duration 5+, where the difference may be spurious) and the combined experience has been graduated. The resulting graduated rates for corresponding durations are generally (but not universally) lower than those for permanent assurances.

(1) Is a standard table for temporary assurances required? The Committee draws attention to its remarks in section 1.2 about AIDS. Would a standard table be any more than just of historical interest?

(2) If a standard table were to be produced, is the Committee's proposed pattern of durations in the select period (viz: 0, 1–4, 5+) suitable?

(3) The graduated tables need to be adjusted and possibly extended. What is the practical age range required for such a table? Does it need to go up to the highest ages? How low does it need to go?

5. LINKED ASSURANCES, MALES

5.1 INTRODUCTIION

The C.M.I. investigation into the mortality experience of linked assurances began in 1976. The quadrennium 1979–82 is therefore the first period of four years included in the usual cycle of C.M.I. investigations. The investigation is defective in a number of respects, some of which were noted in the Committee's report in C.M.I.R. **8**. Only a limited number of offices contribute to the investigation; of those that do, some cannot subdivide their data by duration, and therefore their returns are included wholly with the data for duration 5+; many cannot subdivide their data by medical type, and therefore their returns are included wholly in the 'combined' (medical and non-medical) section. Some offices find it difficult to differentiate and exclude cases with restricted life cover (for example, return of premiums on death within the first two years, or single premium bonds with a sum assured of 101% of the investment value of the bond), and their returns have had to be excluded. The consequence of these defects is that the mortality investigation of a large and important class of business is restricted to being rather a small one.

The numbers of deaths and of exposed to risk are shown below.

	Medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	13	3,212·0	73	51,537·0
1	21	2,318·0	63	30,862·0
2	11	2,111·5	62	25,975·0
3	26	2,091·0	83	25,948·5
4	26	2,452·5	84	25,213·5
5+	332	36,367·0	1,183	323,290·5

	Combined (including many not categorised by medical type)	
Duration	Deaths	Central exposed
0	197	130,652·5
1	166	98,567·5
2	147	82,796·5
3	159	72,581·5
4	159	65,277·0
5+	1,906	553,956·5

The usual age ranges are given for the combined data only. There is rather little exposure and few deaths beyond age 65. Inspection of the data for individual ages

suggests that there is some indication of clusters of duplicate policies at a small number of high ages.

Duration	Range of data	Combined Exposed ≥ 100	Deaths ≥ 10
0	10–99	16–68	—
1	10–100	18–67	—
2	10–97	19–63	—
3	10–84	20–63	—
4	10–81	21–64	—
5+	10–99	22–72	34–65

5.2 COMPARISON WITH PERMANENT ASSURANCES

Table 5.1 shows the usual comparisons between the experiences for permanent assurances and linked assurances (in both cases for the medically combined data) for

Table 5.1

Male assured lives, combined. Comparison of data for same durations Permanent (I) versus Linked (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	96·6	107·3	25	22	0·7200	23	0·3935	225·4	0·0000
1	100·2	99·5	25	25	0·5561	23	0·2368	80·2	0·0043
2	98·8	105·0	21	26	0·2800	22	0·3031	157·2	0·0000
3	97·5	111·7	16	28	0·0481	25	0·9176	95·2	0·0000
4	98·5	109·2	18	23	0·2664	25	0·9172	85·6	0·0001
5+	100·9	84·1	52	19	1·0000	25	0·1602	249·2	0·0000
0–1	98·9	102·9	33	27	0·8169	32	0·6819	196·2	0·0000
1–2	99·4	102·0	29	30	0·5000	27	0·2154	146·4	0·0000
2–3	98·2	107·7	23	34	0·0924	28	0·5044	166·2	0·0000
3–4	98·0	110·6	20	36	0·0220	25	0·3613	157·0	0·0000
4+	100·9	85·1	50	23	0·9995	27	0·0887	280·1	0·0000
0–2	99·1	102·6	30	32	0·4495	32	0·5549	200·0	0·0000
1–3	99·0	104·0	26	36	0·1264	29	0·3279	163·5	0·0000
2–4	98·4	107·8	27	33	0·2595	28	0·2818	171·7	0·0000
3+	100·9	86·6	51	26	0·9986	27	0·0219	302·4	0·0000
0–3	98·9	103·5	22	41	0·0113	26	0·1880	205·3	0·0000
1–4	99·0	104·4	26	38	0·0843	28	0·1885	160·1	0·0000
2+	101·0	86·5	44	33	0·9145	25	0·0009	324·6	0·0000
0–4	99·0	103·5	25	39	0·0517	30	0·3961	188·3	0·0000
1+	101·1	86·2	51	29	0·9952	20	0·0000	431·7	0·0000
0+	101·2	86·6	49	32	0·9776	24	0·0002	503·0	0·0000

each duration and combination of durations. In the select period linked assurances have a somewhat higher level of mortality than permanent assurances, though the difference is hardly significant overall. For duration 5+ linked assurances show a significantly lower level of mortality than permanent assurances; there are two reasons, however, why this may not be important: first, the experience is newer than that for permanent assurances, and therefore duration 5+ is on average a lower duration; and secondly, the experience for 5+ is 'diluted' by the returns from offices which cannot differentiate by duration.

5.3 COMPARISON OF DURATIONS

Table 5.2 shows the usual comparison of the experience of each single duration with each other duration for the medically combined linked assurances, along with comparisons for certain combinations of durations. There is evidence of a selection 'gradient' from duration 0 to duration 4, but duration 5+ is lower than either of durations 3 and 4, and has almost the same level of mortality as durations 0 to 4

Table 5.2

Male assured lives, linked, combined. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	93·1	109·6	6	14	0·0577	6	0·0575	30·7	0·0598
0	2	91·0	115·2	6	11	0·1662	8	0·4357	31·7	0·0163
0	3	85·8	125·9	4	12	0·0384	6	0·3352	30·4	0·0160
0	4	85·8	125·7	3	12	0·0176	7	1·0000	145·4	0·0000
0	5+	85·6	101·8	7	13	0·1316	12	0·8842	70·5	0·0000
1	2	97·0	103·6	9	11	0·4119	9	0·2549	15·6	0·7382
1	3	91·7	110·5	7	13	0·1316	10	0·5700	17·1	0·6456
1	4	87·5	117·6	6	12	0·1189	7	0·2054	74·7	0·0000
1	5+	95·3	100·4	14	12	0·7214	13	0·4296	39·6	0·0430
2	3	92·8	107·7	7	13	0·1316	12	0·8842	15·0	0·7763
2	4	89·4	112·2	7	10	0·3145	7	0·1818	55·7	0·0000
2	5+	98·2	100·1	10	11	0·5000	15	0·9651	12·5	0·9242
3	4	97·9	102·2	11	9	0·7483	11	0·6050	14·8	0·7872
3	5+	116·5	98·8	17	7	0·9887	12	0·7692	31·1	0·1506
4	5+	117·5	98·8	15	5	0·9941	9	0·7417	43·5	0·0017
0	1–4	80·6	108·1	5	16	0·0133	10	0·8524	60·4	0·0000
0	1+	81·5	101·8	7	14	0·0946	12	0·8561	69·5	0·0000
0–1	2+	85·6	102·6	12	28	0·0083	16	0·2985	98·7	0·0000
0–2	3+	89·4	102·8	15	27	0·0442	22	0·7688	114·7	0·0000
0–3	4+	95·4	101·6	19	24	0·2712	20	0·2970	156·8	0·0000
0–4	5+	100·1	100·0	19	25	0·2257	22	0·4883	82·0	0·0004
1–4	5+	105·3	98·4	25	18	0·8890	21	0·4449	61·9	0·0311

combined. Duration 0 can be more clearly separated from durations 1–4 than can any other of the select durations from the others.

The experiences for the following durations were graduated: 0, 1–4, 5+. For durations 1–4 and 5+ a GM(2,2) formula was clearly suitable, although the high number of apparent duplicate policies at certain ages distorted the value of χ^2. For duration 0 a GM(2,2) formula was not unsuitable, although the r-parameters were not significantly different from zero. A GM(0,2) formula fitted the data adequately, except at the youngest ages. Summary results for these graduations are shown in Table 5.3.

The distance D between the parameters for the GM(2,2) graduations was calculated. The values of D and of $p(D)$ are shown below:

	Value of D	
Duration	0	1–4
1–4	31·59	—
5+	16·95	7·04

	Value of $p(D)$	
Duration	0	1–4
1–4	0·0000	—
5+	0·0020	0·1338

The parameters for duration 0 are significantly different from those for the other two duration groups, but those for durations 1–4 and 5+ are not significantly different from each other.

When the parameters are compared with those for male permanent assurances for corresponding durations the following results are obtained.

Duration	Values of D	Value of $p(D)$
0	22·43	0·0002
1–4	21·79	0·0002
5+	108·60	0·0000

The parameters for each duration in the linked assurances experience are not very close to those for the corresponding duration of the permanent assurances. However, when linked assurances duration 5+ is compared with permanent assurances durations 1–4 the value of D is 9·53, and that of $p(D)$ is 0·0492, indicating that the parameters for these two experiences are reasonably close.

The values of the graduated q_x for the two formulae for duration 0 are not very close, even in the age range where the deaths are most heavily concentrated. The values of q_x for durations 1–4 and 5+ are rather more similar over the central part of the age range. But the pattern of rates as the durations increase is clearly not suitable for the construction of the normal sort of graduated table.

Table 5.3.

Male assured lives, linked, combined. Statistics for graduations of $\mu_x = \mathrm{GM}(r,s)$

Duration	0	0	1–4	5+
Formula	GM(0,2)	GM(2,2)	GM(2,2)	GM(2,2)
Values of parameters at optimum point:				
$100\ a_1$	—	0·001560	−1·168466	−0·669642
T-ratio	—	0·02	−1·71	−2·09
$100\ a_2$	—	−0·036654	−1·059554	−0·726073
T-ratio	—	−0·45	−2·13	−2·45
b_1	−3·989441	−3·838353	−3·444413	−3·525947
T-ratio	−33·28	−29·90	−20·53	−45·56
b_2	4·755927	5·887968	2·636835	3·612742
T-ratio	18·28	11·16	3·62	6·08
Signs test: *p*(pos)	0·3555	0·5000	0·3359	0·3327
Runs test: *p*(runs)	0·9917	0·6519	0·5757	0·7825
K–S test: *p*(*KS*)	0·1098	0·5041	1·0000	1·0000
Serial Correlation test:				
T-ratio 1	−0·95	−1·32	−0·68	−0·06
T-ratio 2	1·44	−0·64	−1·50	−1·10
T-ratio 3	−0·88	1·20	−0·44	0·97
χ^2 test:				
χ^2	139·14	124·44	79·40	58·61
Degrees of freedom	27	25	46	44
$p(\chi^2)$	0·0000	0·0000	0·0016	0·0693
Specimen values of q_x percentage standard errors.				
Age 20	0·000167	0·000442	0·001151	0·001314
percentage s.e.	20·67	25·72	127·31	32·08
Age 30	0·000432	0·000511	0·000662	0·000735
percentage s.e.	15·05	16·03	223·88	48·20
Age 40	0·001119	0·000899	0·001304	0·001079
percentage s.e.	10·38	14·59	112·60	37·44
Age 50	0·002893	0·002324	0·003857	0·003322
percentage s.e.	7·78	11·16	34·35	12·74
Age 60	0·007473	0·007098	0·009627	0·009453
percentage s.e.	8·94	11·65	11·56	4·41
Age 70	0·019232	0·022601	0·020771	0·023464
percentage s.e.	12·79	12·91	11·14	7·05
Age 80	0·049029	0·071436	0·040780	0·053161
percentage s.e.	17·51	16·37	17·56	13·44
Age 90	0·122029	0·213911	0·075119	0·112876
percentage s.e.	21·87	20·76	25·40	20·95
Age 100	0·286025	0·542338	0·131800	0·225461
percentage s.e.	23·85	20·04	34·08	27·83
Age 110	0·581960	0·920974	0·221175	0·415243
percentage s.e.	19·90	9·91	41·70	29·94

5.4 QUESTIONS FOR THE PROFESSION

The Committee's view is that, even though the level of mortality for linked assurances appears to be higher than that for permanent assurances during the select period, the experience for linked assurances is not yet sufficiently reliable for a standard table for this class of policy to be constructed. Does the profession agree?

6. PERMANENT ASSURANCES, FEMALES

6.1 THE DATA

The Committee first prepared standard tables for females for permanent assurances in the United Kingdom based on the 1975–78 experience, the FA1975–78 tables. (See 'Graduation of the Mortality Experience of Female Assured Lives 1975–78', C.M.I.R. **6**, 1.) The 1979–82 experience is for the next following quadrennium, and it would not have been surprising if the experience had not changed very much. When the Committee reported on this experience for 1979–82, however, it was clear that the level of mortality had already reduced, at least at durations 0 and 2+. A question for this enquiry is whether the change is significant, and, if so, whether it is sufficiently large to justify preparing new standard tables.

The investigation is the same as that for males in being divided into Medical and Non-medical sections, and having a five year select period.

The FA1975–78 table was constructed with a two year selection period. The function graduated was q_x and the formula for duration 2+ was LGM(0,5). For the select durations the same formula was used, with the same parameters except for an age adjustment, which was chosen by a maximum likelihood criterion.

The numbers of deaths and the central exposed to risk for each section and for each duration are shown below. A comparison with the male experience shows that the numbers of exposed to risk among females in the select durations are about one-third of those among males, whereas at duration 5+ the female experience falls to about one ninth of the male. This suggests that the female experience is much less mature than that of the males, and the average duration of the 5+ data may be much lower than that of the males.

	Medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	38	33,786·0	383	686,188·5
1	74	35,782·0	527	629,111·5
2	54	35,752·5	516	548,069·5
3	66	34,785·5	457	470,507·5
4	63	31,992·0	450	394,207·5
5+	1,074	187,780·5	3,688	1,672,749·5

	Combined	
Duration	Deaths	Central exposed
0	421	719,974·5
1	601	664,893·5
2	570	583,822·0
3	523	505,293·0
4	513	426,199·5
5+	4,762	1,860,530·0

The usual age ranges are noted below: the extreme limits of the data; the continuous range over which the exposed to risk at each age exceeds 100; and the continuous range over which the deaths at each age exceed 10. Each range for each duration is noted below, except for the select durations in the Medical section in which very few ages have more than 10 deaths.

	Medical			Non-medical		
	Range	Exposed	Deaths	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10	of data	≥ 100	≥ 10
0	13–93	17–75	—	10–87	13–74	49–55
1	10–93	18–76	—	10–87	13–74	46–59
2	13–90	19–71	—	10–83	14–72	44–60
3	10–90	20–72	—	10-100	15–73	47–61
4	11–93	21–70	—	10–85	16–72	52–61
5+	10–108	22–91	49–93	10–102	16–87	26–85

	Combined		
	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10
0	10–93	13–76	49–55
1	10–93	13–76	51–59
2	10–90	14–77	44–60
3	10–100	15–76	47–61
4	10–93	16–76	52–61
5+	10–108	16–93	26–97

As for the males, the Non-medical section provides the bulk of the data for the select durations, but, because the investigation is less mature than that of the males, it also provides relatively great weight (as compared with the Medical section) at the higher ages. In the select durations the female experience covers the same sort of age range as the male, although deaths are rather sparse. In duration 5+ the female experience has much less data at the highest ages than the male.

When the FA1975–78 tables were constructed no adjustments to the data were made to allow for duplicates. There was no indication of a large number of duplicates in the select durations, but the value of χ^2 for duration 2+ was relatively large. Information was available to the Committee which allowed variance ratios to be calculated for the 1979-82 experience. Records from the cause of death investigation were available for about 56% of the deaths during the quadrennium, and from these the variance ratios were derived. These were used to adjust the exposed to risk and the deaths for durations 2+ and 5+.

6.2 COMPARISON OF DURATIONS

The experiences of the different durations are compared in Table 6.1. Variance ratios have been used to adjust the data for duration 5+. It is clear that duration 0 has

Table 6.1 *Female assured lives, permanent, Combined. Comparison of data for different durations*

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	80·9	119·9	8	34	0·0000	14	0·5472	84·4	0·0001
0	2	81·4	120·3	7	34	0·0000	14	0·8100	77·7	0·0005
0	3	82·3	121·0	9	30	0·0005	15	0·6250	79·0	0·0002
0	4	79·4	127·0	5	33	0·0000	9	0·4555	81·1	0·0001
0	5+	56·8	109·0	3	38	0·0000	5	0·1462	207·7	0·0000
1	2	99·9	100·1	24	20	0·7743	25	0·7945	35·6	0·8140
1	3	100·4	99·6	20	24	0·3258	23	0·5817	51·9	0·1938
1	4	96·6	104·3	20	24	0·3258	29	0·9808	36·6	0·7773
1	5+	80·3	103·9	10	39	0·0000	14	0·1315	82·1	0·0021
2	3	101·0	99·0	20	22	0·4388	31	0·9988	42·2	0·4623
2	4	97·1	103·4	16	25	0·1055	21	0·6282	38·1	0·6010
2	5+	80·1	103·8	11	33	0·0006	16	0·3194	98·4	0·0000
3	4	96·4	103·9	16	25	0·1055	21	0·6282	54·5	0·0767
3	5+	78·7	103·8	11	34	0·0004	17	0·4840	99·5	0·0000
4	5+	84·8	102·4	14	31	0·0080	20	0·5147	45·1	0·4674

a significantly lower level of mortality than the others, and duration 5+ significantly higher. Durations 1, 2, 3 and 4 are not only not significantly different, but also do not show any noticeable selection gradient. There is good justification therefore in grouping them together. However, the precedent of FA1975–78 suggested that the following durations should be investigated: 0, 1, 2–4, 1–4, 5+ and 2+.

6.3 SELECT DURATIONS

The experiences of the select groups of durations were graduated by fitting μ_x to a GM(r,s) formula. For each of the four experiences a number of low order formulae would fit satisfactorily, and gave rather similar values of q_x in the main age range. It was difficult to choose between them. For durations 0 and 1 a GM(1,2) (Makeham) formula was satisfactory; GM(1,3) and GM(2,2) fitted rather better, but the added parameters (b_2 and a_1 respectively) were not significantly different from zero. For durations 2–4 and 1–4 a GM(1,2) formula did not fit satisfactorily, but GM(1,3) and GM(2,2) were about equally good. Summaries for the GM(1,2) formulae for durations 0 and 1 and for the GM(2,2) formulae for all four duration groups are given in Table 6.2.

6.4 ULTIMATE DURATIONS

In the ultimate data, for durations 2+ and 5+, the same feature was found as for

Table 6.2.

Female assured lives, permanent. Statistics for graduations of select durations

Duration	0	0	1	1	2–4	1–4
Formula	GM(1,2)	GM(2,2)	GM(1,2)	GM(2,2)	GM(2,2)	GM(2,2)
Values of parameters at optimum point:						
$100\ a_1$	0·011995	−0·169572	0·015253	−0·076446	−0·192614	−0·149271
T-ratio	3·19	−1·47	3·71	−1·24	−2·55	−2·94
$100\ a_2$	—	−0·158677	—	−0·089013	−0·182901	−0·148663
T-ratio	—	−1·74	—	−1·55	−2·83	−3·32
b_1	−4·877787	−4·755196	−4·272106	−4·253324	−4·271633	−4·270806
T-ratio	−43·14	−43·40	−49·46	−53·89	−85·34	−105·96
b_2	4·928510	3·243579	5·396489	4·608019	3·656370	3·945977
T-ratio	13·23	4·41	18·69	8·77	9·97	13·28
Signs test: *p*(pos)	0·1611	0·5573	0·2522	0·1144	0·1528	0·0517
Runs test: *p*(runs)	0·2008	0·4433	0·2765	0·6507	0·0013	0·0575
K–S test: *p*(*KS*)	0·7640	0·9842	0·9366	0·9948	0·9520	0·8900
Serial Correlation test:						
T-ratio 1	0·98	0·15	−0·04	0·00	0·90	1·03
T-ratio 2	0·44	0·21	−0·91	−1·73	−0·11	−0·59
T-ratio 3	−0·93	−0·36	−0·38	−1·29	0·87	0·98
χ^2 test:						
χ^2	67·03	55·62	56·55	55·90	70·98	67·39
Degrees of freedom	47	44	53	52	57	60
$p(\chi^2)$	0·0290	0·1125	0·3440	0·3306	0·1009	0·2390
Specimen values of q_x and percentage standard errors.						
Age 20	0·000178	0·000222	0·000219	0·000265	0·000259	0·000260
percentage s.e.	15·16	88·61	14·58	19·91	19·80	12·11
Age 30	0·000275	0·000222	0·000349	0·000312	0·000296	0·000300
percentage s.e.	7·76	94·59	7·35	16·36	17·41	9·35
Age 40	0·000536	0·000510	0·000730	0·000699	0·000767	0·000746
percentage s.e.	6·39	43·76	5·49	10·65	8·77	5·32
Age 50	0·001234	0·001352	0·001852	0·001938	0·002140	0·002084
percentage s.e.	5·91	16·69	4·96	6·82	4·52	3·35
Age 60	0·003101	0·003249	0·005146	0·005316	0·005377	0·005378
percentage s.e.	6·26	8·88	4·88	6·30	3·73	3·15
Age 70	0·008089	0·007155	0·014775	0·014020	0·012459	0·012944
percentage s.e.	10·56	12·01	7·92	9·26	5·73	4·86
Age 80	0·021331	0·014871	0·042574	0·035821	0·027397	0·029748
percentage s.e.	17·01	19·58	12·55	15·28	9·63	8·12
Age 90	0·055952	0·029747	0·119906	0·088755	0·058087	0·066075
percentage s.e.	24·07	29·82	17·13	22·65	14·45	12·07
Age 100	0·142806	0·057855	0·313091	0·209531	0·119137	0·141638
percentage s.e.	30·07	42·48	19·25	28·90	19·48	15·99
Age 110	0·338149	0·109638	0·668726	0·447197	0·233928	0·287402
percentage s.e.	30·81	55·78	14·34	28·70	23·43	18·61

the males, that the observed crude mortality rates at the highest ages appeared unrealistically low. The observed experience for ages above 90 was therefore omitted in the graduation process, as was done for the males.

A low order GM(r,s) formula was found not to fit either the 2+ or the 5+ data satisfactorily. The number of runs was always too low, and the other graduation tests proved unsatisfactory. Only formulae with six or more parameters provided satisfactory fits; of these GM(1,5) was the best. But the values of q_x for this formula reached a maximum in the 90s of age and dropped thereafter. Some other formulae with six or more parameters also fitted the data, but had unsatisfactory shapes, or very wide sheaves. Trial graduations of q_x with a LGM(r,s) formula gave similar results. The choice lay between a lower order formula which was the right sort of shape, but which cut across 'waves' in the experience rates (and of these the GM(2,2) was on balance the best), and a GM(1,5) formula that followed the waves, but also included an undesirable wave at the highest ages. Summaries of the graduations for durations 2+ and 5+ on both these formulae are given in Table 6.3.

6.5 COMPARISON OF GRADUATIONS

Since all six duration groups had been graduated using a GM(2,2) formula, it was possible to compare the distances between the maximum likelihood parameters in the parameter space in the usual way. Values of D and of $p(D)$ are shown below.

	Values of D				
Duration	0	1	2–4	1–4	2+
1	38·20	—	—	—	—
2–4	31·36	3·27	—	—	—
1–4	66·90	1·90	0·61	—	—
2+	177·82	22·82	61·86	55·38	—
5+	192·84	37·57	63·83	67·29	9·44

	Values of $p(D)$				
Duration	0	1	2–4	1–4	2+
1	0·0000	—	—	—	—
2–4	0·0000	0·5142	—	—	—
1–4	0·0000	0·7541	0·9623	—	—
2+	0·0000	0·0002	0·0000	0·0000	—
5+	0·0000	0·0000	0·0000	0·0000	0·0510

It can be seen that the parameters for durations 1, 2–4 and 1–4 are not significantly different from each other. This justifies combining duration 1 with durations 2–4 to form duration 1–4. Duration 0 and the two ultimate durations are significantly different from durations 1–4, but durations 2+ and 5+ are (not surprisingly) not significantly different.

6.6 COMPARISON WITH MALE EXPERIENCE

Table 6.4 shows the usual statistics for the comparison of the male and female experiences for permanent assurances for corresponding durations and groups of durations. It can be seen that the level of mortality for females is little more than half that for males.

Each of the corresponding durations of the experience for male permanent assurances has been graduated using the GM(2,2) formula. The table below shows the value of D when each of the female durations is compared with each of the male ones.

	Values of D Females					
Males	0	1	2–4	1–4	2+	5+
0	56·68	24·61	30·03	37·40	171·47	91·13
1	111·44	62·29	86·06	112·58	236·60	111·18
2–4	157·38	78·42	152·56	199·91	228·61	119·70
1–4	160·64	84·98	153·78	206·06	246·57	123·82
2+	604·61	196·42	764·09	845·39	829·92	472·55
5+	568·89	199·92	732·04	804·21	856·67	494·14

The value of D should be compared with $\chi^2(4)$. In every case the value of $p(D)$ is nearly zero. There is no doubt that the male and female experiences are very different.

6.7 COMPARISON OF MEDICAL AND NON-MEDICAL EXPERIENCES

Table 6.5 shows the usual comparisons for each duration or group of durations when the female medical experience is compared with the non-medical. The pattern of ratios of A/E is similar to that for males shown in Table 3.5, though the smaller numbers of deaths among the females mean that many of the differences for individual durations are not statistically significant.

The rather small numbers of deaths in the select durations for the medical experience make it not worth while graduating the medical and non-medical experiences separately, as was done for the males.

6.8 COMPARISON WITH 1975–78 GRADUATIONS

Since different orders of formulae have been used for the graduation of the 1979–82 experience than the 1975–78 graduations, it is not possible to compare the distances between the parameters. The values of q_x that result are compared in section 14 below, where it will be seen that the rates for the later period are substantially below those for 1975–78.

Table 6.3.
Female assured lives, permanent. Statistics for graduations of ultimate durations

Duration	2+	2+	5+	5+
Formula	GM(2,2)	GM(1,5)	GM(2,2)	GM(1,5)
Values of parameters at optimum point:				
$100\,a_1$	−0·015700	0·031751	0·014688	0·038533
T-ratio	−0·78	16·34	0·46	12·30
$100\,a_2$	−0·025164	—	0·003753	—
T-ratio	−1·20	—	0·11	—
b_1	−4·064944	−7·190455	−4·031809	−8·143149
T-ratio	−164·71	−15·25	−126·32	−6·19
b_2	5·044225	4·968017	5·192702	3·898739
T-ratio	45·21	11·98	31·26	2·80
b_3	—	−4·528445	—	−5·901321
T-ratio	—	−6·60	—	−3·24
b_4	—	−0·171823	—	−0·580998
T-ratio	—	−0·98	—	−1·10
b_5	—	−1·546249	—	−1·920446
T-ratio	—	−6·72	—	−3·73
Signs test: *p*(pos)	0·5000	0·4561	0·1375	0·4050
Runs test: *p*(runs)	0·0019	0·4574	0·0454	0·6914
K–S test: *p*(*KS*)	0·2195	0·9711	0·3097	0·9989
Serial Correlation test:				
T-ratio 1	2·55	−0·34	1·44	−1·18
T-ratio 2	3·09	0·75	2·57	0·48
T-ratio 3	1·89	−0·08	1·95	−0·02
χ^2 test:				
χ^2	140·97	96·73	107·82	76·17
Degree of freedom	79	76	64	63
$p(\chi^2)$	0·0000	0·0546	0·0005	0·1233

Table 6.3 (*continued*)

Specimen values of q_x and percentage standard errors.

Age 20	0·000209	0·000317	0·000214	0·000385
percentage s.e.	13·20	5·12	24·86	6·79
Age 30	0·000361	0·000335	0·000411	0·000399
percentage s.e.	4·16	4·42	5·56	5·92
Age 40	0·000867	0·000795	0·000953	0·000869
percentage s.e.	2·69	4·53	3·52	5·83
Age 50	0·002340	0·002584	0·002472	0·002767
percentage s.e.	1·83	2·50	2·23	3·15
Age 60	0·006455	0·006147	0·006735	0·006405
percentage s.e.	1·90	2·35	2·24	2·74
Age 70	0·017741	0·015915	0·018667	0·016736
percentage s.e.	2·13	2·52	2·53	3·05
Age 80	0·048121	0·051774	0·051595	0·055417
percentage s.e.	2·87	3·68	3·67	4·67
Age 90	0·126777	0·152626	0·138758	0·146473
percentage s.e.	4·01	4·71	5·45	11·86
Age 100	0·310770	0·200242	0·344084	0·121023
percentage s.e.	4·90	14·81	6·76	73·38
Age 110	0·639827	0·037238	0·696113	0·006487
percentage s.e.	4·46	71·29	5·81	1435·30

Table 6.4

Assured lives, permanent. Comparison of data for same durations Males (I) versus Females (II)

Duration	I A/E	II A/E	Numbers +	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	117·6	61·0	42	2	1·0000	5	1·0000	189·2	0·0000
1	113·0	69·6	46	5	1·0000	7	0·0450	167·2	0·0000
2	112·6	68·1	43	3	1·0000	7	1·0000	165·4	0·0000
3	112·5	65·2	40	5	1·0000	9	0·3941	183·7	0·0000
4	110·6	67·3	43	2	1·0000	5	1·0000	137·6	0·0000
5+	103·2	64·7	72	5	1·0000	9	0·2427	1161·1	0·0000
0–1	115·2	65·5	60	1	1·0000	3	1·0000	335·7	0·0000
1–2	112·8	68·8	56	3	1·0000	7	1·0000	308·1	0·0000
2–3	112·6	66·6	54	0	1·0000	1	1·0000	314·7	0·0000
3–4	111·6	66·1	54	0	1·0000	1	1·0000	293·1	0·0000
4+	103·6	64·0	74	4	1·0000	7	0·1497	1349·7	0·0000
0–2	114·4	66·2	61	1	1·0000	3	1·0000	472·5	0·0000
1–3	112·8	67·5	61	0	1·0000	1	1·0000	446·2	0·0000
2–4	112·0	66·7	58	1	1·0000	3	1·0000	436·1	0·0000
3+	104·0	63·1	75	4	1·0000	7	0·1479	1573·1	0·0000
0–3	114·0	65·7	62	0	1·0000	1	1·0000	620·9	0·0000
1–4	112·3	67·3	62	0	1·0000	1	1·0000	562·7	0·0000
2+	104·4	62·5	77	3	1·0000	5	0·0750	1793·3	0·0000
0–4	113·4	65·7	64	0	1·0000	1	1·0000	744·5	0·0000
1+	104·8	62·0	79	3	1·0000	5	0·0731	2030·3	0·0000
0+	105·4	60·4	80	3	1·0000	5	0·0723	2394·1	0·0000

6.9 QUESTIONS FOR THE PROFESSION

The Committee is aware that it has been common practice among life offices to calculate premium rates and possibly valuation reserves for female assured lives by using a male table with an age adjustment. Such an age adjustment at younger ages clearly cannot represent the female mortality rates correctly (because the male rates fall with increasing age) and a constant adjustment does not represent the female experience at higher ages, as shown in C.M.I.R. **8**. Since separate tables for the two sexes for annuities and pensions are long established, the Committee would prefer to put assurances onto the same basis as far as its own work is concerned.

The Committee therefore inclines towards preparing standard tables for males and females for permanent assurances in parallel, and towards making future comparisons of the experience on the basis only of tables for the same sex, i.e. omitting any comparison based on an age adjustment. What is the view of the profession?

Table 6.7.

Female assured lives, permanent, Medical and Non-medical. Comparison of data for same durations Medical (I) versus Non-medical (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	95·9	100·4	3	4	0·5000	4	0·5429	12·2	0·0955
1	99·6	100·1	5	8	0·2905	4	0·0536	30·8	0·0036
2	76·9	103·2	2	8	0·0547	5	1·0000	9·4	0·4957
3	91·5	101·4	5	6	0·5000	6	0·5216	13·3	0·2743
4	78·7	103·9	2	8	0·0547	5	1·0000	10·6	0·3908
5+	93·3	102·2	20	39	0·0092	28	0·6129	88·8	0·0073
0–1	97·8	100·3	7	10	0·3145	6	0·0800	39·8	0·0014
1–2	88·3	101·7	6	12	0·1189	6	0·0869	32·6	0·0188
2–3	82·3	102·7	6	11	0·1662	8	0·4357	27·4	0·0531
3–4	83·6	102·9	7	10	0·3145	9	0·5490	17·5	0·4209
4+	92·0	102·4	20	39	0·0092	28	0·6129	90·1	0·0056
0–2	90·6	101·2	8	15	0·1050	6	0·0101	36·5	0·0364
1–3	88·3	101·7	10	18	0·0925	10	0·0798	46·1	0·0168
2–4	80·6	103·2	9	16	0·1148	10	0·1842	32·6	0·1415
3+	91·7	102·4	22	40	0·0150	28	0·3962	99·4	0·0018
0–3	90·9	101·3	14	17	0·3601	12	0·0779	51·8	0·0109
1–4	85·2	102·3	12	21	0·0814	12	0·0748	46·5	0·0602
2+	90·8	102·6	23	40	0·0215	28	0·3162	103·6	0·0010
0–4	87·6	101·8	14	24	0·0717	12	0·0145	61·4	0·0096
1+	91·3	102·3	24	40	0·0300	24	0·0404	119·9	0·0000
0+	91·9	102·0	26	39	0·0680	24	0·0224	125·7	0·0000

7. LINKED ASSURANCES, FEMALES

7.1 INTRODUCTION

The investigation into the mortality experience of linked assurances on female lives began in 1976 at the same time as that for males. The comments made about the defects of the male investigation apply also to that for females. In particular, some offices provide only combined medical and non-medical data, and some offices submit all their data in duration 5+. It is possible that not all cases with restricted life cover have been excluded.

The numbers of deaths and of exposed to risk are shown below. The exposed to risk is substantially smaller than that for males, and the numbers of deaths are very much smaller.

	Medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	5	911·0	9	19,318·5
1	3	673·5	14	11,380·0
2	4	637·0	26	9,791·5
3	1	628·5	25	9,927·0
4	5	760·0	28	9,528·5
5+	40	7,465·0	184	74,695·0

	Combined (including many not categorised by medical type)	
Duration	Deaths	Central exposed
0	40	27,838·0
1	27	17,633·0
2	35	13,775·5
3	27	13,008·0
4	34	12,297·0
5+	256	95,541·5

The usual age ranges are given below for the combined data only. Although the exposed to risk covers a reasonable range of ages, deaths are very sparse except in the 50's of age. There is no evidence of large numbers of duplicate policies generally, though it is possible that a block of simultaneous duplicates at one age has been included.

		Combined	
	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10
0	10–99	16–68	—
1	10–92	20–67	—
2	10–93	22–61	—
3	10–91	23–61	—
4	10–86	25–62	—
5+	10–97	23–67	53–62

7.2 COMPARISON WITH PERMANENT ASSURANCES

Table 7.1 shows the usual comparisons between the experiences for permanent assurances and linked assurances for each duration and combination of durations. As for the males, in the select period linked assurances have a somewhat higher level of mortality than permanent assurances, though the differences in this case are nowhere significant. For duration 5+ linked assurances for females show a significantly lower level of mortality than permanent assurances. The same reasons why this result may be misleading apply as for the males.

7.3 COMPARISON OF DURATIONS

Table 7.2 shows the usual comparison of the experience of each single duration with each other duration for the medically combined linked assurances, along with comparisons for certain combinations of durations. There is some selection

Table 7.1

Female assured lives, combined. Comparison of data for same durations Permanent (I) versus Linked (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	91·9	106·4	9	5	0·9102	10	0·9720	104·9	0·0000
1	96·7	103·6	8	11	0·3238	11	0·7217	48·0	0·0003
2	96·2	106·6	7	10	0·3145	9	0·5490	65·6	0·0000
3	94·6	111·5	6	9	0·3036	11	0·9720	92·2	0·0000
4	96·7	108·9	6	11	0·1662	7	0·2418	39·8	0·0014
5+	102·5	93·1	39	21	0·9933	22	0·0486	81·2	0·0356
0–1	98·2	101·5	17	13	0·8192	12	0·1113	114·2	0·0000
1–2	97·4	103·3	16	16	0·5700	19	0·8138	106·5	0·0000
2–3	97·8	103·8	14	13	0·6494	11	0·1189	76·2	0·0000
3–4	98·1	104·0	10	19	0·0680	15	0·7223	73·2	0·0000
4+	102·1	94·3	35	29	0·8091	27	0·0919	90·5	0·0162
0–2	98·9	101·2	20	19	0·6254	18	0·2610	153·1	0·0000
1–3	97·9	103·0	16	26	0·0821	17	0·1371	103·2	0·0000
2–4	98·1	103·7	19	20	0·5000	17	0·1650	83·0	0·0001
3+	101·7	95·4	34	33	0·5964	35	0·5971	120·2	0·0001
0–3	98·8	101·4	26	18	0·9129	22	0·5265	163·0	0·0000
1–4	97·8	103·4	21	25	0·3294	23	0·4599	101·9	0·0000
2+	101·8	95·5	36	34	0·6399	39	0·8019	134·5	0·0000
0–4	98·9	101·5	25	22	0·7200	25	0·6259	149·2	0·0000
1+	101·3	97·1	43	29	0·9618	33	0·2991	191·2	0·0000
0+	101·6	96·9	41	31	0·9027	33	0·2485	240·4	0·0000

Table 7.2

Female assured lives, linked, combined. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	97·7	103·7	1	2	0·5000	2	0·6667	7·2	0·0655
0	2	76·2	155·3	1	2	0·5000	2	0·6667	26·2	0·0000
0	3	86·3	130·7	1	1	0·7500	2	1·0000	11·4	0·0033
0	4	74·1	169·9	0	3	0·1250	1	1·0000	20·7	0·0001
0	5+	57·4	113·1	1	3	0·3125	2	0·5000	28·0	0·0000
1	2	75·5	133·3	0	4	0·0625	1	1·0000	5·9	0·2088
1	3	84·4	122·6	0	4	0·0625	1	1·0000	2·8	0·5838
1	4	73·6	139·9	0	4	0·0625	1	1·0000	7·8	0·1011
1	5+	75·8	103·5	0	4	0·0625	1	1·0000	3·1	0·5335
2	3	110·6	88·9	4	0	1·0000	1	1·0000	1·2	0·8721
2	4	98·4	101·7	2	2	0·6875	3	0·6667	5·1	0·2728
2	5+	125·1	97·3	4	2	0·8906	4	0·8000	7·8	0·2504
3	4	88·3	111·7	2	2	0·6875	3	0·6667	4·6	0·3334
3	5+	105·3	99·5	2	3	0·5000	3	0·5000	2·5	0·7718
4	5+	129·8	97·0	4	2	0·8906	3	0·4000	6·1	0·4124
0	1–4	68·0	118·0	1	3	0·3125	2	0·5000	29·2	0·0000
1–4	5+	99·2	100·4	8	9	0·5000	7	0·1573	15·5	0·5628
0	1+	59·4	107·8	3	3	0·6563	2	0·1000	32·3	0·0000
0–1	2+	61·1	113·8	2	6	0·1445	2	0·0714	36·0	0·0000
0–2	3+	74·3	112·5	1	11	0·0032	2	0·1667	22·0	0·0373
0–3	4+	80·8	111·8	5	10	0·1509	8	0·6783	27·5	0·0252
0–4	5+	89·3	108·3	8	10	0·4073	8	0·2514	16·1	0·5872

'gradient' from duration 0 upwards, and durations 2 and 4 seem distinctly high compared with the other durations, but none of the differences is significant.

The experiences for the same durations as for males were graduated, viz: 0, 1–4 and 5+. The small number of deaths meant that a low order formula was suitable for all these groups, and the most satisfactory formula that fitted all of them was GM(1,2), even though the value of parameter a_0 was generally not significantly different from zero. Summaries of the graduations for each of these durations with a GM(1,2) formula are shown in Table 7.3. The high value of χ^2 for durations 1–4 is attributable to a high number of deaths at one age (53), where it is possible that a block of simultaneous duplicates has not been excluded.

Table 7.3.

Female assured lives, linked, combined. Statistics for graduations of μ_x=GM(1,2)

Duration	*0*	*1–4*	*5+*
Values of parameters at optimum point:			
100 a_1	0·018432	0·004286	0·048498
T-ratio	1·65	0·13	2·13
b_1	−4·675796	−4·528942	−4·182455
T-ratio	−22·21	−28·04	−31·37
b_2	9·002346	3·770454	5·632805
T-ratio	10·67	5·54	8·97
Signs test: *p*(pos)	0·5000	0·5000	0·5775
Runs test: *p*(runs)	1·0000	0·9233	0·7228
K–S test: *p*(*KS*)	0·9941	0·9805	0·9985
Serial Correlation test:			
T-ratio 1	−1·75	−1·44	−0·63
T-ratio 2	1·36	0·61	−0·40
T-ratio 3	−1·49	−2·45	−0·65
χ^2 test:			
χ^2	10·14	42·67	17·32
Degrees of freedom	4	16	23
$p(\chi^2)$	0·0382	0·0003	0·7934
Specimen values of q_x and percentage standard errors.			
Age 20	0·000186	0·000301	0·000543
percentage s.e.	57·07	69·21	38·75
Age 30	0·000192	0·000592	0·000663
percentage s.e.	54·66	27·46	27·83
Age 40	0·000230	0·001209	0·001035
percentage s.e.	44·85	13·34	14·00
Age 50	0·000463	0·002520	0·002180
percentage s.e.	29·99	9·96	7·53
Age 60	*0·001869*	*0·005302*	*0·005705*
percentage s.e.	24·80	9·52	6·81
Age 70	0·010340	0·011189	0·016501
percentage s.e.	17·20	15·81	12·08
Age 80	0·060097	0·023588	0·049075
percentage s.e.	17·98	27·29	22·35
Age 90	0·312154	0·049429	0·142923
percentage s.e.	24·40	41·64	32·94
Age 100	0·896051	0·102110	0·377981
percentage s.e.	10·86	56·34	34·77
Age 110	*0·999999*	*0·204596*	*0·768625*
percentage s.e.	0·19	64·48	19·51

The distance D between the parameters for the GM(1,3) graduations was calculated. The values of D and of $p(D)$ are shown below:

	Value of D	
Duration	0	1–4
1–4	31·62	—
5+	23·12	4·45

	Value of $p(D)$	
Duration	0	1–4
1–4	0·0000	—
5+	0·0000	0·2172

As for the males, the parameters for duration 0 are significantly different from those for the other two duration groups, but those for durations 1–4 and 5+ are not significantly different from each other.

7.4 QUESTIONS FOR THE PROFESSION

The Committee's view about this experience is the same as its view about that for linked assurances for males, that it is not yet sufficiently reliable for a standard table for this class of policy to be constructed, even less so for females than for males. Does the profession agree?

8. PERMANENT ASSURANCES, MALES, REPUBLIC OF IRELAND

8.1 THE DATA

The Committee considered the 1975–78 experience of males assured for permanent assurances in the Republic of Ireland in their report 'On a possible graduation of the Irish Assured Lives Mortality Experience', C.M.I.R. **6**, 37. On that occasion it was shown that the experience in Ireland could be well represented by that of the A1967–70 tables, which were appropriate to the United Kingdom some eight years previously. The numbers of deaths in the data for durations 0 and 1 were very small, so only duration 2+ was considered at that time in any detail.

The numbers of deaths and the central exposed to risk in 1979–82 for both the Medical and Non-medical sections and for each duration are shown below. The numbers of deaths in the select durations are small, though a little bigger than in 1975–78, but the numbers at duration 5+ are ample for graduation.

	Medical		Non-medical	
Duration	Deaths	Central exposed	Deaths	Central exposed
0	12	6,657·0	69	60,950·0
1	19	7,656·0	60	55,284·5
2	23	8,320·5	59	49,664·0
3	27	9,238·5	64	44,741·0
4	32	10,008·5	60	39,798·0
5+	2,388	246,074·0	1,889	449,131·5

	Combined	
Duration	Deaths	Central exposed
0	81	67,607·0
1	79	62,940·5
2	82	57,984·5
3	91	53,979·5
4	92	49,806·5
5+	4,277	695205·50

The usual age ranges are noted below: the extreme limits of the data; the continuous range over which the exposed to risk at each age exceeds 100; and the continuous range over which the deaths at each age exceed 10. Each range for each

duration is noted below, except for the select durations in which no single age has as many as 10 deaths.

	Medical			Non-medical		
	Range	Exposed	Deaths	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10	of data	≥ 100	≥ 10
0	11–77	23–45	—	10–81	17–56	—
1	12–76	23–48	—	11–76	18–57	—
2	13–77	24–49	—	11–77	19–58	—
3	14–77	25–52	—	12–78	19–58	—
4	15–78	26–60	—	13–79	20–56	—
5+	13–106	25–85	43–86	10–95	21–73	34–68

	Combined		
	Range	Exposed	Deaths
Duration	of data	≥ 100	≥ 10
0	10–81	17–59	—
1	11–76	18–59	—
2	11–77	19–60	—
3	12–78	19–61	—
4	13–79	20–62	—
5+	10–106	21–86	34–86

8.2 COMPARISON WITH UNITED KINGDOM

Table 8.1 shows a comparison for each duration and each consecutive group of durations of the experience for male permanent assurances in the United Kingdom versus the corresponding Irish experience. It is clear that the Irish experience is significantly higher than the UK experience, by about 25 per cent overall. Only duration 1 shows a possibly non-significant difference by both the signs test and the χ^2 test.

8.3 COMPARISON OF DURATIONS

Table 8.2 shows a comparison of the different durations of the Irish experience among themselves. There is hardly any difference between the levels of mortality for any of the select durations, far less a significant one. Duration 5+, however, shows higher mortality than any of the select durations, hardly significant when compared with each separately, but clearly significant when compared with durations 0–4 combined, as shown in the last line of the table.

If there had been no previous investigation, it would have been appropriate to graduate only durations 0–4 combined and 5+. Since duration 2+ had been considered for the 1975–78 data, durations 0–1 and 2+ were also graduated on this occasion.

Table 8.1

Male assured lives, permanent. Comparison of data for same durations United Kingdom (I) versus Ireland (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	98·6	147·7	2	12	0·0065	3	0·1538	32·4	0·0035
1	99·5	119·0	5	9	0·2120	8	0·7343	13·7	0·4742
2	99·5	118·6	3	11	0·0287	5	0·4231	18·2	0·2000
3	99·3	124·5	5	9	0·2120	7	0·5105	41·0	0·0002
4	99·4	122·5	4	11	0·0592	7	0·6703	26·3	0·0353
5+	98·5	123·5	8	62	0·0000	17	1·0000	370·1	0·0000
0–1	99·0	132·9	6	18	0·0113	9	0·3917	37·4	0·0395
1–2	99·4	119·6	6	18	0·0113	11	0·8161	27·3	0·2917
2–3	99·4	122·3	8	16	0·0758	13	0·8104	51·5	0·0009
3–4	99·3	124·0	8	15	0·1050	11	0·5103	87·3	0·0000
4+	98·5	123·9	9	61	0·0000	19	1·0000	373·1	0·0000
0–2	99·2	128·4	6	26	0·0003	13	1·0000	51·0	0·0178
1–3	99·4	122·2	8	24	0·0035	15	0·9068	58·6	0·0028
2–4	99·3	123·5	13	20	0·1481	15	0·3200	84·9	0·0000
3+	98·5	124·4	10	61	0·0000	21	1·0000	384·5	0·0000
0–3	99·2	128·0	9	33	0·0001	16	0·6937	80·4	0·0003
1–4	99·4	122·7	13	25	0·0365	21	0·8984	81·0	0·0001
2+	98·5	124·8	12	60	0·0000	24	0·9271	402·2	0·0000
0–4	99·2	127·1	16	28	0·0481	22	0·6395	96·4	0·0000
1+	98·5	125·3	13	59	0·0000	26	0·9555	420·2	0·0000
0+	98·5	126·5	9	64	0·0000	19	1·0000	449·1	0·0000

8.4 CHOICE OF ORDER OF FORMULA

The four duration groups 0–1, 2+, 0–4 and 5+ were graduated separately, fitting μ_x with a GM(r,s) formula and using a maximum likelihood criterion. The results showed that there was, for all but one of them, a choice of two possible orders of formula, each with some merits.

For duration 2+ a GM(2,2) formula was clearly the best, fitting the data as well as any other, and amply satisfying all tests except the χ^2 test. Inspection of the data for individual ages showed that certain ages had unusually high or low numbers of deaths, such that no reasonably smooth curve would pass through both their gates and those of their neighbours. These ages were 44 (low) and 66, 78 and 80 (high).

The presence of duplicates has not been investigated for the Irish data, but these results suggest that there may be a proportion of duplicates in the ultimate data. The 1975–78 experience had also shown a very large value of χ^2, with certain ages sticking out as on this occasion.

Table 8.2 *Male assured lives, permanent, Ireland, combined. Comparison of data for different durations*

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	101·0	99·0	7	5	0·8062	6	0·4242	5·8	0·9268
0	2	98·9	101·1	5	6	0·5000	7	0·7381	9·6	0·5684
0	3	97·7	102·2	5	4	0·7461	4	0·2619	8·3	0·4999
0	4	96·0	103·8	5	6	0·5000	5	0·2619	9·8	0·5499
0	5+	78·1	100·5	3	10	0·0461	5	0·4545	16·4	0·2292
1	2	98·1	101·9	5	7	0·3872	7	0·6515	7·1	0·8486
1	3	95·1	104·7	5	5	0·6230	5	0·3571	16·4	0·0878
1	4	94·1	105·7	5	5	0·6230	5	0·3571	6·5	0·7730
1	5+	76·5	100·6	2	12	0·0065	3	0·1538	14·7	0·4004
2	3	95·9	104·1	5	5	0·6230	5	0·3571	10·1	0·4346
2	4	94·2	105·8	4	7	0·2744	5	0·3333	11·1	0·4345
2	5+	77·4	100·6	5	9	0·2120	9	0·9021	19·6	0·1419
3	4	99·5	100·5	6	7	0·5000	6	0·2960	3·4	0·9959
3	5+	86·9	100·3	7	7	0·6047	9	0·7914	33·0	0·0029
4	5+	87·2	100·3	8	7	0·6964	9	0·7040	21·1	0·1336
0–4	5+	86·5	101·6	11	30	0·0022	19	0·8464	65·0	0·0099

Each of the other durations could be fitted by a μ_x=GM(2,2) formula, but in no case was it clearly the best. For durations 0–1 the value of L_I for the GM(2,2) formula was indeed 2.8 greater than that for a GM(1,2) formula, but the added r-parameter (a_1) was not significantly different from zero, and the GM(1,2) graduation was quite acceptable on all counts.

For durations 0–4 the GM(2,2) formula was again acceptable, but the value of L_I for it was 1.0 less than that for a GM(1,3) formula, which has the same number of parameters. The value of χ^2 for the GM(2,2) formula (53.63) was distinctly greater than that for the GM(1,3) formula (42.74), though the values of $p(\chi^2)$ for both were acceptable (0·1077 and 0·4392 respectively). However, values of q_x for the GM(1,3) formula reached a maximum at age 71 and turned down sharply thereafter.

For duration 5+ a GM(2,2) formula was again acceptable, but the value of the L_I criterion for a GM(3,3) formula was 3·9 greater, and the added parameters were significantly different from zero. One effect of a substantial number of duplicates in the data is to give greater values both of χ^2 and of the L_I criterion, so the improvement in the criterion may not be in reality as significant as it looks. A further effect is to reduce the standard errors of the parameter estimates so that they appear more significantly different from zero than they really are. But even the higher order formula does not produce a value of $p(\chi^2)$ that is noticeably different from zero.

Summaries of all the formulae discussed are given in Table 8.3. The resulting values of q_x are reasonably close for the two formulae for duration 5+. For the

Table 8.3.

Male assured lives, permanent, Ireland. Statistics for graduations of μ_x

Duration	0–1	0–1	2+	0–4	0–4	5+	5+
Formula	GM(1,2)	GM(2,2)	GM(2,2)	GM(1,3)	GM(2,2)	GM(2,2)	GM(3,3)
Values of parameters at optimum point:							
$100\ a_0$	0·058622	−0·381469	−0·513886	0·066232	−0·632225	−0·627714	3·113200
T-ratio	5·13	−1·28	−5·69	9·87	−1·83	−5·17	6·36
$100\ a_1$	—	−0·444829	−0·580795	—	−0·649339	−0·717474	4·306276
T-ratio	—	−1·61	−6·05	—	−2·20	−5·41	6·21
$100\ a_2$	—	—	—	—	—	—	1·461466
T-ratio	—	—	—	—	—	—	5·99
b_0	−3·177935	−3·311458	−3·094460	−8·881095	−3·348213	−3·061794	−5·830651
T-ratio	−12·68	−16·38	−116·51	−5·46	−35·95	−95·82	−6·59
b_1	7·072263	4·686948	4·561444	0·432778	3·778648	4·450980	7·215368
T-ratio	8·73	3·81	30·47	0·25	4·67	26·73	10·42
b_2	—	—	—	−4·957641	—	—	−2·110637
T-ratio	—	—	—	−3·46	—	—	−2·60
Signs test: *p*(pos)	0·2024	0·5000	0·7220	0·2307	0·2307	0·4050	0·8322
Runs test: *p*(runs)	0·2572	0·0992	0·8637	0·7161	0·9317	0·2385	0·3431
K–S test: *p*(*KS*)	0·9918	0·9935	0·9489	1·0000	0·9859	0·8980	0·9904
Serial Correlation test:							
T-ratio 1	1·12	−0·75	−0·59	−0·98	−1·00	−0·56	−0·59
T-ratio 2	−0·66	0·28	0·37	−0·51	−0·04	0·38	−0·11
T-ratio 3	−0·04	−0·62	−1·11	−0·74	0·11	−1·00	−1·14
χ^2 test:							
χ^2	20·79	17·01	140·56	42·74	53·63	140·62	126·37
Degrees of freedom	20	19	68	42	42	65	63
$p(\chi^2)$	0·4094	0·5891	0·0000	0·4392	0·1077	0·0000	0·0000
Specimen values of q_x and percentage standard errors.							
Age 20	0·000624	0·000941	0·001106	0·000663	0·000940	0·001396	0·002351
percentage s.e.	15·24	73·54	12·95	9·03	47·91	15·25	18·87
Age 30	0·000742	0·000599	0·000683	0·000691	0·000584	0·000782	0·000746
percentage s.e.	11·32	113·46	7·81	7·88	80·71	10·19	20·04
Age 40	0·001228	0·001106	0·001359	0·001148	0·001290	0·001343	0·001364
percentage s.e.	10·14	64·83	4·43	9·75	40·34	5·26	18·27
Age 50	0·003225	0·003777	0·004765	0·004352	0·004255	0·004761	0·004923
percentage s.e.	11·21	21·58	2·18	8·12	13·00	2·39	8·17
Age 60	0·011401	0·011930	0·014901	0·013305	0·011986	0·015069	0·014573
percentage s.e.	13·19	15·78	1·91	9·79	9·00	2·00	4·40
Age 70	0·044336	0·033784	0·041354	0·020286	0·029673	0·041707	0·042094
percentage s.e.	22·51	25·59	2·17	26·96	14·81	2·21	3·32
Age 80	0·168688	0·088675	0·105726	0·014538	0·067651	0·105454	0·111682
percentage s.e.	33·13	42·78	3·28	92·06	23·84	3·35	4·59
Age 90	0·531529	0·216180	0·249154	0·005111	0·144889	0·245094	0·235653
percentage s.e.	28·61	58·12	4·67	384·97	34·04	4·87	8·87
Age 100	0·955751	0·467298	0·514982	0·001306	0·289732	0·501723	0·371580
percentage s.e.	8·78	49·14	5·25	1809·04	40·49	5·62	22·68
Age 110	0·999997	0·801567	0·836913	0·000704	0·522278	0·819225	0·448488
percentage s.e.	0·72	30·07	3·63	3380·04	35·75	4·12	40·51

lower durations the formulae produce values of q_x that are some distance apart, the curves crossing and recrossing; but the difference between the values of q_x is usually less than one standard error (except for high ages for duration 0–4 where the GM(1,3) formula turns down), so the differences are not significant, given the limited amount of data on which they are based.

Both for the 0–4, 5+ series, and for the 0–1, 2+ series the values of q_x on the GM(2,2) formula increase appropriately with duration for a particular value of x.

Further, the levels of these graduations at the highest ages are more comfortable than those of some of the alternatives, neither falling away, as does the GM(1,3) formula for duration 0–4, nor rising rather sharply, as does the GM(1,2) formula for duration 0–1.

8.5 COMPARISONS BETWEEN GRADUATED FORMULAE

The distances between the parameter estimates of the four GM(2,2) graduations were compared in the usual way. The values of D and of $p(D)$ are shown below.

	Value of D			Value of $p(D)$		
Duration	0–1	0–4	2+	0–1	0–4	2+
0–4	0·92	—	—	0·9210	—	—
2+	3·57	7·61	—	0·4667	0·1070	—
5+	5·03	9·88	1·39	0·2884	0·0425	0·8465

The only sets of parameters that are significantly different, and that only at a 5% level, are those for 0–4 and 5+. These were the duration groups that presented themselves as contrasting when the crude rates were compared.

8.6 QUESTIONS FOR THE PROFESSION

If a new standard table for Irish permanent assurances is required, the values given by the GM(2,2) formulae for durations 0–4 and 5+ seem to be the most suitable as a basis. Does the profession agree or would durations 0–1 and 2+ be more convenient? The Committee will particularly welcome comment from those involved with life assurance business in the Republic of Ireland.

9. IMMEDIATE ANNUITANTS, MALES AND FEMALES.

9.1 THE DATA

The C.M.I. experience for immediate annuitants has formed the basis of two previous sets of standard tables, $a(55)$ and $a(90)$. Although the experience is smaller than that of assured lives or of life office pensioners, there is an ample number of deaths for the purposes of graduation. In the past the experience has been gathered only on the basis of 'Lives'. On this occasion, however, 'Amounts' were also available.

The investigation uses a five year select period, and is further subdivided into annuities effected before 1957, all of which are now 'ultimate', and annuities effected after 1956, subdivided by duration. The totals of deaths and exposed to risk, by Lives and by Amounts, for both sexes, are given below.

	Males		Females	
	Lives		Lives	
Duration	Deaths	Central exposed	Deaths	Central exposed
Pre-1957				
5+	217	1,409·0	1,758	12,983·5
Post-1956				
0	122	2,933·5	154	3,967·0
1	142	3,208·5	196	4,718·0
2	169	3,481·0	240	5,538·5
3	180	3,652·0	271	5,963·0
4	157	3,612·0	281	5,834·0
5+	4,123	47,550·0	8,801	120,084·0

	Males		Females	
	Amounts		Amounts	
Duration	Deaths	Central exposed	Deaths	Central exposed
Pre-1957				
5+	23,729	170,123·0	160,007	1,230,572·0
Post-1956				
0	174,875	3,463,312·0	201,549	4,567,483·0
1	200,086	3,244,384·0	265,572	4,698,639·5
2	192,573	3,169,447·0	269,121	4,947,576·5
3	174,819	2,985,973·0	245,552	4,802,773·0
4	143,144	2,774,425·5	286,475	4,490,510·0
5+	3,1467963	33,218,058·0	4,275,562	60,150,114·0

The usual ranges, based on a count of Lives, are shown below, except where the number of ages with more than 10 deaths is too few to note.

	Males			Females		
Duration	Range of data	Exposed ≥ 100	Deaths ≥ 10	Range of data	Exposed ≥ 100	Deaths ≥ 10
Pre-1957						
5+	51–108	—	90–96	31–108	70–100	76–101
Post-1956						
0	21–99	70–78	—	15–101	70–85	—
1	22–100	70–78	—	16–101	66–86	—
2	23–101	67–79	—	24–101	66–87	—
3	22–102	67–79	—	25–102	63–88	—
4	23–102	67–80	—	21–102	64–88	—
5+	24–108	62–97	66–99	21–107	56–100	66–99

Although there are occasional entries at young ages, the bulk of the experience lies above age 65, and the pre-1957 experience above age 75.

9.2 COMPARISON OF DURATIONS

Both the $a(55)$ tables and the $a(90)$ tables had been constructed with a one year select period. It is appropriate, however, to investigate whether this is still justified. It is also of interest to see whether the pre-1957 data could justifiably be merged with the post-1956 ultimate data. Tables 9.1 and 9.2 show the usual comparisons of durations for the Lives data, males and females respectively, including a comparison of the pre-1957 and post-1956 data for duration 5+.

Both sexes show the same pattern. There is no significant difference between any of the select durations; there is a marginal difference between any one of the select durations and duration 5+, but a clear difference between durations 0–4 taken together and 5+; and the pre-1957 experience is higher than the post-1956 experience, with marginal significance.

The evidence of these tables suggests graduating durations 0–4 together, and 5+ for the post-1956 data, keeping pre-1957 aside. Following the previous precedent, however, it was desirable also to graduate durations 0 and 1+, and it was of interest to graduate the pre-1957 data separately and also to combine it with the post-1956 5+ data.

9.3 CHOICE OF ORDER OF FORMULA

When the *aeg*1967–70 tables (on which the $a(90)$ tables were based) were constructed, the function q_x was graduated, with a LGM(0,s) formula. It was found that a 2-parameter formula, LGM(0,2), would fit the data for males for durations 0 and 1+, and the data for females for duration 0, but it was thought necessary to go

Table 9.1

Immediate annuitants, Lives, Males. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	97·8	102·0	9	7	0·7728	10	0·8059	10·7	0·8255
0	2	94·5	104·4	7	10	0·3145	12	0·9571	15·9	0·5280
0	3	93·1	105·3	6	11	0·1662	11	0·9423	14·0	0·6648
0	4	99·8	100·2	7	8	0·5000	10	0·8671	14·7	0·4704
0	5+	71·7	101·2	6	12	0·1189	10	0·7831	27·9	0·0629
1	2	97·2	102·5	10	9	0·6762	11	0·6814	8·5	0·9811
1	3	97·1	102·4	7	12	0·1796	13	0·9751	13·7	0·8006
1	4	104·9	95·9	11	6	0·9283	9	0·6538	13·5	0·7056
1	5+	75·8	101·1	4	16	0·0059	9	1·0000	21·8	0·3525
2	3	99·6	100·4	12	9	0·8083	14	0·9311	20·3	0·5023
2	4	107·7	92·8	11	6	0·9283	9	0·6538	16·3	0·5053
2	5+	80·8	101·0	7	15	0·0669	11	0·6864	26·2	0·2440
3	4	108·1	92·1	14	5	0·9904	9	0·7663	16·6	0·6165
3	5+	80·1	101·1	8	16	0·0758	16	0·9913	24·0	0·4624
4	5+	70·5	101·6	4	18	0·0022	9	1·0000	38·2	0·0176
0	1+	74·5	100·9	6	12	0·1189	10	0·7831	25·7	0·1074
0–4	5+	79·3	105·1	4	31	0·0000	7	0·3215	81·4	0·0000
Pre	Post									
5+	5+	104·4	99·8	14	7	0·9608	8	0·1760	23·6	0·3148

to LGM(0,4) for females duration 1+. It is not necessary that the same order of formula be used for all durations, although it aids certain comparisons if this is possible.

On this occasion the function μ_x was fitted, using a GM(r,s) formula. For each of the twelve data sets considered it was found that a GM(0,2) formula provided a satisfactory fit to the data in respect of the number of runs and the serial correlation coefficients. For the duration 0 data for both sexes no higher order formula was justifiable, the value of $p(\chi^2)$ being quite satisfactory. But for all the other data sets a higher order formula was a strong contender, showing a significantly greater value of the L_1 criterion and a substantially lower value of χ^2. In most cases this higher order formula was GM(1,3), but for females duration 0–4 a GM(0,3) formula was enough.

Although this higher order formula gave a greater value of L_1 for none of the ultimate durations did it, or any other order of formula, give a value of χ^2 that was satisfactorily low. Inspection of the data for individual ages showed certain ages in each experience where the numbers of deaths were unusually high, so much so that no reasonably smooth curve could pass through their gates as well as the

Table 9.2

Immediate annuitants, Lives, Females. Comparison of data for different durations

Durations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	1	96·5	102·9	10	8	0·7597	11	0·7822	17·4	0·4936
0	2	93·4	104·8	9	10	0·5000	9	0·3186	14·1	0·7766
0	3	90·2	106·6	7	12	0·1796	8	0·2475	15·2	0·7122
0	4	88·1	108·0	6	13	0·0835	9	0·5609	23·5	0·2159
0	5+	78·4	100·5	5	14	0·0318	8	0·4958	21·6	0·3057
1	2	97·1	102·5	12	11	0·6612	15	0·9008	13·1	0·9498
1	3	94·1	104·7	9	15	0·1537	13	0·7104	23·7	0·4775
1	4	92·3	106·2	8	13	0·1917	12	0·7718	16·4	0·7452
1	5+	83·8	100·4	7	17	0·0320	12	0·7692	26·3	0·3393
2	3	97·3	102·5	14	13	0·6494	15	0·6525	23·6	0·6515
2	4	95·8	103·9	10	15	0·2122	9	0·0673	21·9	0·6412
2	5+	87·7	100·4	9	18	0·0610	11	0·2545	30·7	0·2837
3	4	98·0	102·0	13	13	0·5775	12	0·2772	30·5	0·2467
3	5+	92·2	100·3	14	15	0·5000	16	0·6519	51·6	0·0061
4	5+	95·4	100·2	11	16	0·2210	13	0·4116	22·5	0·7134
0	1+	79·4	100·4	5	14	0·0318	8	0·4958	20·3	0·3750
0–4	5+	89·7	101·5	13	23	0·0662	15	0·2203	58·1	0·0113
Pre	Post									
5+	5+	104·8	99·1	21	12	0·9599	19	0·8956	64·2	0·0009

neighbouring gates. No adjustment for duplicates had been made, but it was known that in the 1967–70 investigation one particular death had had a very large number of annuity contracts, and investigation of the cause of death data for annuitants showed that on this occasion too there were a few lives (or rather deaths) who had had several contracts. No special adjustment was made for these, but it was reasonable to assume that a high value of χ^2, contributed to by one or two very large values of z_x, was acceptable, if the graduation passed the other goodness of fit tests.

If there are such duplicates, and the numbers of cases are not adjusted for them, the value of the L_1 criterion is inflated. If the original numbers of exposed to risk and of deaths should have been adjusted by a constant variance ratio of r at all ages, but are not so adjusted, then the values of L_1 and of χ^2 are simply r times bigger than the correct values. This affects also the differences between the values of L_1 for different orders of formula. It was therefore appropriate to accept a rather lower order formula, even if its value of L_1 appeared too low, provided that it was not much too low.

Table 9.3 gives summaries of the graduations for males, and Table 9.4 gives them for females. For males the formulae shown are:

Duration 0:	GM(0,2)
Duration 1+:	GM(0,2) and GM(1,3)
Duration 0–4:	GM(0,2)
Duration 5+:	GM(0,2) and GM(1,3)
Pre-1957:	GM(0,2) and GM(1,3)
Combined duration 5+:	GM(1,3)

For females the same formulae are shown, except that for duration 0–4 GM(0,3) replaces GM(0,2).

In general the GM(0,2) formulae (being simple Gompertz formulae) produce values of q_x that are implausibly low when projected to the youngest ages, and in general the GM(1,3) formulae have a rather large value of the a_0 parameter, so produce rather large values at the youngest ages, but in these cases the standard errors of the estimates of q_x are also fairly large. For the pre-1957 male experience the GM(1,3) formula produces values of q_x that reach a maximum at age 96 and fall thereafter; this would be an undesirable feature in a standard table, but it seems unlikely that there will be any requirement for a standard table based on this particular experience.

9.4 COMPARISON OF GRADUATED FORMULAE

The distance between the parameters of the graduated formulae can be readily compared when the formulae are of the same order. All the duration groups were fitted with a GM(0,2) formula (including females duration 0–4), and all were fitted with a GM(1,3) formula. In each case all twelve formulae were compared with each of the others. The values of $p(D)$ for the GM(0,2) comparisons are shown below.

Values of $p(D)$

Males

Duration	0	1+	0–4	5+	Pre-1957
1+	0·0014	—	—	—	—
0–4	0·5806	0·0000	—	—	—
5+	0·0003	0·0859	0·0000	—	—
Pre-1957	0·0003	0·1526	0·0000	0·2274	—
Combined	0·0003	0·1235	0·0000	0·7105	0·2960

Females

Duration	0	1+	0–4	5+	Pre-1957
1+	0·0190	—	—	—	—
0–4	0·3789	0·0021	—	—	—
5+	0·0118	0·6821	0·0004	—	—
Pre-1957	0·0000	0·0000	0·0000	0·0000	—
Combined	0·0068	0·1470	0·0000	0·5654	0·0000

Table 9.3. *Immediate annuitants, males. Statistics for graduations of* $\mu_x = \mathrm{GM}(r,s)$

Duration	0	1+	1+	0–4	5+	5+	Pre-1957	Pre-1957	Combined 5+
Formula	GM(0,2)	GM(0,2)	GM(1,3)	GM(0,2)	GM(0,2)	GM(1,3)	GM(0,2)	GM(1,3)	GM(1,3)
Values of parameters at optimum point:									
$100\,a_0$	—	—	1·861718	—	—	2·443344	—	6·782605	2·607978
T-ratio	—	—	6·51	—	—	6·90	—	6·26	7·87
b_0	−3·514486	−3·375783	−7·037803	−3·512485	−3·333657	−8·013221	−3·051095	−39·647582	−8·333035
T-ratio	−29·42	−126·00	−8·74	−70·17	−108·25	−7·86	−17·53	−2·99	−8·44
b_1	3·332467	4·327411	8·661782	3·764248	4·320872	9·951869	3·687948	51·901876	10·388649
T-ratio	6·32	46·11	9·11	18·16	40·84	8·11	8·56	2·99	8·66
b_2	—	—	−2·756305	—	—	−3·470437	—	−25·116085	−3·684685
T-ratio	—	—	−4·38	—	—	−4·43	—	−2·72	−4·89
Signs test: p(pos)	0·7728	0·3830	0·1856	0·6286	0·5612	0·1802	0·5806	0·5841	0·5000
Runs test: p(runs)	0·8059	0·8267	0·9798	0·5000	0·7835	0·8719	0·1504	0·7401	0·3789
K–S test: $p(KS)$	0·9985	0·4733	0·9494	0·9701	0·4318	0·9684	0·5645	1·0000	0·9440
Serial Correlation test:									
T-ratio 1	−1·22	−0·33	−1·85	−0·45	0·14	−1·41	0·96	−1·00	−1·51
T-ratio 2	−0·67	0·20	−0·70	−0·41	−0·38	−0·97	0·74	−0·42	−0·42
T-ratio 3	0·05	−0·06	−1·27	−0·71	0·39	−0·87	0·96	−1·33	−0·93
χ^2 test:									
χ^2	19·63	109·52	86·65	58·82	88·72	73·55	30·88	17·88	82·42
Degrees of freedom	14	43	41	35	40	39	22	18	39
$p(\chi^2)$	0·1424	0·0000	0·0000	0·0071	0·0000	0·0007	0·0986	0·4637	0·0001
Specimen values of q_x and percentage standard errors.									
Age 20	0·001098	0·000471	0·018445	0·000718	0·000495	0·024137	0·001228	0·065577	0·025743
percentage s.e.	93·48	12·43	12·39	27·44	14·23	11·65	87·30	12·59	10·20
Age 30	0·002138	0·001120	0·018445	0·001523	0·001174	0·024137	0·002565	0·065577	0·025743
percentage s.e.	69·32	10·39	12·38	22·28	11·90	11·65	69·03	12·59	10·20
Age 40	0·004159	0·002659	0·018457	0·003232	0·002783	0·024140	0·005357	0·065577	0·025744
percentage s.e.	50·05	8·39	12 27	17·43	9·62	11·62	53·53	12·59	10·19
Age 50	0·008083	0·006306	0·018646	0·006848	0·006593	0·024212	0·011167	0·065577	0·025796
percentage s.e.	34·48	6·44	11·45	12·88	7·39	11·26	40·27	12·59	9·96
Age 60	0·015680	0·014918	0·020591	0·014484	0·015574	0·025360	0·023207	0·065577	0·026738
percentage s.e.	21·91	4·55	7·80	8·71	5·24	8·89	28·80	12·57	8·17
Age 70	0·030309	0·035084	0·033136	0·030499	0·036564	0·035552	0·047910	0·065578	0·036048
percentage s.e.	12·87	2·83	3·36	5·32	3·25	3·81	18·88	12·41	3·67
Age 80	0·058175	0·081362	0·081927	0·063644	0·084599	0·084081	0·097560	0·068309	0·083721
percentage s.e.	11·25	1·70	1·63	4·30	1·86	1·84	10·83	13·37	1·86
Age 90	0·110164	0·182617	0·188911	0·130302	0·189222	0·197897	0·193165	0·222234	0·199449
percentage s.e.	17·04	2·11	1·96	6·32	2·22	2·14	7·22	8·32	2·07
Age 100	0·203316	0·380688	0·308467	0·256507	0·392116	0·311068	0·361594	0·242205	0·312539
percentage s.e.	24·05	3·03	6·93	8·88	3·26	7·55	9·98	28·46	6·78
Age 110	0·357660	0·679709	0·351038	0·467015	0·693101	0·315692	0·608728	0·069641	0·308922
percentage s.e.	28·72	3·07	20·50	10·23	3·29	24·40	12·18	110·03	22·63

Table 9.4. *Immediate annuitants, females. Statistics for graduations of* $\mu_x = \mathrm{GM}(r,s)$

Duration	0	1+	1+	0–4	5+	5+	Pre–1957	Pre–1957	Combined 5+
Formula	GM(0,2)	GM(0,2)	GM(1,3)	GM(0,3)	GM(0,2)	GM(1,3)	GM(0,2)	GM(1,3)	GM(1,3)
Values of parameters at optimum point:									
$100\,a_0$	—	—	0·614337	—	—	0·683695	—	0·374332	0·702516
T-ratio	—	—	3·84	—	—	3·43	—	0·41	3·87
b_0	−4·226617	−3·979448	−5·634017	−3·054790	−3·953519	−5·797144	−3·547873	−5·196425	−6·071181
T-ratio	−27·53	−168·45	−10·99	−7·38	−153·84	−9·84	−46·81	−3·96	−11·83
b_1	5·419216	5·346654	7·371535	4·553445	5·296937	7·543567	4·386474	6·390970	7·805974
T-ratio	10·56	75·71	11·87	11·57	69·73	10·48	24·09	3·79	12·30
b_2	—	—	−1·214857	1·014554	—	−1·359034	—	−1·264480	−1·618522
T-ratio	—	—	−3·11	2·58	—	−3·07	—	−1·40	−4·24
Signs test: p(pos)	0·6682	0·8144	0·9324	0·7388	0·7288	0·7288	0·5660	0·6962	0·8144
Runs test: p(runs)	0·3350	0·6517	0·8894	0·8447	0·7436	0·9718	0·8829	0·9457	0·9473
K–S test: $p(KS)$	0·9740	0·6984	0·9997	1·0000	0·5588	0·9929	0·9997	0·9877	0·9844
Serial Correlation test:									
T-ratio 1	0·43	−0·91	−1·93	−0·31	−0·25	−1·70	−1·09	−1·79	−1·48
T-ratio 2	−0·47	0·21	−0·95	−0·03	0·76	0·16	−0·38	−0·38	−0·57
T-ratio 3	1·04	−0·06	−0·41	−1·11	0·12	−0·76	1·31	1·16	−0·19
χ^2 test:									
χ^2	21·86	84·18	75·52	39·73	73·60	68·41	41·12	40·02	65·20
Degrees of freedom	19	43	41	36	41	39	34	30	41
$p(\chi^2)$	0·2910	0·0002	0·0017	0·3073	0·0013	0·0025	0·1868	0·1044	0·0095
Specimen values of q_x and percentage standard errors.									
Age 20	0·000068	0·000094	0·006125	0·001375	0·000101	0·006814	0·000374	0·003739	0·007001
percentage s.e.	100·97	9·82	21·07	269·46	10·64	23·57	29·19	141·19	20·96
Age 30	0·000202	0·000274	0·006132	0·001660	0·000292	0·006819	0·000900	0·003762	0·007004
percentage s.e.	76·71	8·30	20·89	128·02	9·00	23·42	24·60	140·32	20·88
Age 40	0·000597	0·000798	0·006191	0·002357	0·000843	0·006867	0·002162	0·003923	0·007038
percentage s.e.	57·09	6·81	20·03	65·37	7·38	22·63	20·22	134·39	20·42
Age 50	0·001763	0·002322	0·006592	0·003933	0·002429	0·007224	0·005191	0·004836	0·007338
percentage s.e.	41·00	5·33	16·68	32·93	5·79	19·37	16·01	106·41	18·01
Age 60	0·005204	0·006750	0·008826	0·007713	0·006992	0·009351	0·012435	0·009020	0·009336
percentage s.e.	27·67	3·89	8·85	14·29	4·23	10·81	11·97	48·53	10·52
Age 70	0·015304	0·019539	0·018935	0·017737	0·020037	0·019398	0·029638	0·024348	0·019434
percentage s.e.	16·79	2·51	3·35	4·56	2·74	3·76	8·11	16·14	3·58
Age 80	0·044565	0·055867	0·055456	0·047487	0·056713	0·056326	0·069784	0·068429	0·057363
percentage s.e.	9·85	1·39	1·24	3·25	1·49	1·34	4·59	4·89	1·29
Age 90	0·126076	0·154213	0·156875	0·144077	0·154999	0·157888	0·159645	0·164623	0·158848
percentage s.e.	11·38	1·27	1·19	3·99	1·33	1·27	2·56	2·58	1·14
Age 100	0·328578	0·386125	0·358390	0·442999	0·384807	0·352883	0·341767	0·316938	0·339975
percentage s.e.	16·38	1·91	3·66	9·40	2·02	3·89	3·79	5·42	3·13
Age 110	0·691968	0·758685	0·618936	0·924917	0·753747	0·594126	0·634141	0·485423	0·542964
percentage s.e.	15·51	1·74	8·52	6·05	1·87	9·61	4·71	17·68	8·58

Both sexes show the same pattern. Durations 0 and 0-4 are not significantly different (not surprisingly, since one is included in the other), nor are 1+ and 5+ (for the same reason). In each case the select durations are different from the ultimate. The pre-1957 experience for females is different from any of the post-1956 durations, but for males it is not significantly different from either ultimate duration. The combined 5+ experience behaves as expected.

When the graduated rates for the same ages at different durations are compared we see a number of overlaps that would be undesirable in practical tables. The pattern is the same for both sexes. When the select duration (0 or 0–4 as the case may be) is compared with the ultimate duration (1+ or 5+ respectively) the rates for the select duration exceed those for the ultimate either below about age 60 (when the ultimate duration uses a GM(0,2) formula), or above about age 110 (when a GM(1,3) formula is used); the latter overlap is of no practical importance.

9.5 COMPARISON OF MALE AND FEMALE RATES

Table 9.5 shows a comparison between the male and female experiences for corresponding durations. In every case except one the mortality levels are very clearly different. The exception is duration 4, which can be seen from Tables 9.1 and 9.2 to be rather high for females and rather low for males, in comparison with the neighbouring durations.

The distances between all the graduated GM(0,2) formulae for all the male and female duration groups were also calculated. The corresponding values of p(D) are shown below.

	Values of $p(D)$					
Duration	Males					
Females	0	1+	0–4	5+	Pre-57	Combined
0	0·0012	0·0000	0·0000	0·0000	0·0000	0·0000
1+	0·0002	0·0000	0·0000	0·0000	0·0000	0·0000
0–4	0·0000	0·0000	0·0000	0·0000	0·0000	0·0000
5+	0·0003	0·0000	0·0000	0·0000	0·0000	0·0000
Pre-1957	0·0586	0·0000	0·0053	0·0000	0·0016	0·0000
Combined	0·0009	0·0000	0·0000	0·0000	0·0000	0·0000

In only one case do the graduated rates approach each other. The parameters for the male experience with the lowest mortality, duration 0, are not significantly different from those of the female experience with the highest mortality, the pre-1957 one.

9.6 THE EXPERIENCE BY AMOUNTS

The annuitants' experience is also gathered by Amounts. Amounts data can be treated as containing a great number of duplicates, not of policies, but of pounds. It is desirable to allow for this. For each duration group for each sex the numbers of

Table 9.5

Immediate annuitants, Lives. Comparison of data for same durations Males (I) versus Females (II)

	I	II	Numbers						
Duration	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
0	118·3	89·1	9	5	0·9102	6	0·2867	22·3	0·0726
1	118·5	89·8	12	4	0·9894	8	0·8187	20·6	0·1937
2	122·3	88·6	16	3	0·9996	6	0·5304	24·8	0·1667
3	117·9	90·8	15	6	0·9867	8	0·2655	38·7	0·0108
4	104·7	97·6	13	9	0·8569	10	0·3050	27·7	0·1853
5+	128·7	90·5	37	3	1·0000	6	0·2773	489·5	0·0000
0–1	119·1	89·2	20	7	0·9970	11	0·5286	48·1	0·0076
1–2	120·6	89·1	21	7	0·9981	12	0·6596	50·1	0·0064
2–3	120·5	89·6	24	5	0·9999	4	0·0018	48·4	0·0135
3–4	111·3	94·2	18	12	0·8998	12	0·1312	51·3	0·0090
4+	127·5	90·8	36	4	1·0000	8	0·4271	481·2	0·0000
0–2	120·2	89·0	23	8	0·9983	10	0·1245	58·9	0·0018
1–3	119·9	89·7	25	6	0·9999	6	0·0101	62·4	0·0007
2–4	115·1	92·3	22	9	0·9947	6	0·0007	55·2	0·0047
3+	127·0	90·8	37	4	1·0000	8	0·4183	502·2	0·0000
0–3	119·6	89·5	24	8	0·9989	6	0·0013	76·7	0·0000
1–4	115·9	91·8	25	8	0·9993	8	0·0150	71·7	0·0001
2+	126·7	90·8	36	6	1·0000	8	0·0415	505·6	0·0000
0–4	116·2	91·4	27	7	0·9999	6	0·0023	90·0	0·0000
1+	126·3	90·8	36	6	1·0000	8	0·0415	513·4	0·0000
0+	126·0	90·8	36	6	1·0000	8	0·0415	525·1	0·0000
Pre 57	123·7	97·7	16	5	0·9964	4	0·0069	53·2	0·0001

exposed to risk and deaths at each age have been scaled down by the average amount of annuity in the central exposed to risk (for all ages). The average amounts are given below.

Duration	Males	Females
0	1,180.61	1,151.37
1+	738.04	556.43
0–4	926.01	903.40
5+	698.59	500.90
Pre-1957	120.74	94.78
Combined 5+	681.96	461.27

For each experience the expected number of deaths according to the graduated rates for the corresponding lives experience, using the GM(0,2) formula, was

calculated, and compared with the observed number of deaths (both measured in units of the size shown above). The results are shown below.

Duration	Actual deaths (units)	Males Expected deaths (units)	100A/E
0	148·1	143·8	103·0
1+	5,226·5	5,260·5	99·4
0–4	949·5	907·8	104·6
5+	4,504·5	4,504·1	100·0
Pre-1957	196·5	221·7	88·6
Combined 5+	4,649·1	4,659·6	99·8

Duration	Actual deaths (units)	Females Expected deaths (units)	100A/E
0	175·0	199·4	87·8
1+	9,610·0	5,260·5	94·7
0–4	1,403·9	1,415·0	99·2
5+	8,535·8	9,097·8	93·8
Pre-1957	1,688·2	1,731·7	97·5
Combined 5+	9,615·9	10,294·7	93·4

In many cases the actual and expected deaths are very close. For males only the pre-1957 experience shows a value of 100A/E that is much different from 100, and inspection of the detailed results shows that the difference is not significant. For females the value of 100A/E is close to 100 for durations 0–4 and for the pre-1957 experience; for duration 0 the value is low but not very significantly so; but for any duration that includes the data for 5+ the Amounts experience is significantly lower than the Lives experience, by some 6% or so.

Each of the Amounts experiences was graduated using the GM(0,2) formula. Summaries of the results are shown in Tables 9.6 and 9.7. The parameters of the graduations and the resulting values of q_x are very close to those of the corresponding Lives graduations, except for females 1+, 5+ and Combined 5+. The maximum value of the L_t criterion was compared with the value using the parameters of the corresponding Lives graduations. The differences are shown below.

Duration	Males	Females
0	0·1	2·4
1+	3·0	14·8
0–4	1·9	0·3
5+	0·6	18·1
Pre-1957	3·8	0·7
Combined 5+	0·3	24·7

Table 9.6.

Immediate annuitants, males, Amounts. Statistics for graduations of $\mu_x = \mathrm{GM}(r,s)$

Duration	0	1+	0–4	5+	Pre–1957	Combined
Formula	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)
Values of parameters at optimum point:						
b_1	−3·523917	−3·326425	−3·411835	−3·304492	−3·571347	−3·305291
T-ratio	−27·10	−123·92	−67·03	−107·06	−17·19	−108·69
b_2	3·481943	4·114088	3·494124	4·214091	4·724770	4·215120
T-ratio	6·95	46·34	18·04	42·27	9·61	43·05
Signs test: *p*(pos)	0·7483	0·3220	0·2025	0·2148	0·3318	0·2148
Runs test: *p*(runs)	0·8851	0·4599	0·4988	0·4928	0·9931	0·4928
K–S test: *p*(*KS*)	0·9955	0·1343	0·7517	0·0960	0·4043	0·0935
Serial Correlation test:						
T-ratio 1	−1·01	0·82	−0·46	0·65	−1·69	0·66
T-ratio 2	−2·24	−0·48	−0·20	−0·85	1·53	−0·85
T-ratio 3	*0·54*	*−1·45*	*−0·05*	*−1·34*	*−1·27*	*−1·36*
χ^2 test:						
χ^2	37·22	278·26	169·50	319·49	65·53	307·55
Degrees of freedom	18	40	34	38	19	38
$p(\chi^2)$	0·0049	0·0000	0·0000	0·0000	0·0000	0·0000
Specimen values of q_x and percentage standard errors.						
Age 20	0·000938	0·000612	0·001037	0·000566	0·000262	0·000565
percentage s.e.	91·02	11·94	26·19	13·62	111·39	13·38
Age 30	0·001882	0·001392	0·002085	0·001315	0·000673	0·001313
percentage s.e.	68·77	10·02	21·45	11·44	86·69	11·24
Age 40	0·003773	0·003167	0·004189	0·003052	0·001730	0·003047
percentage s.e.	50·72	8·13	16·96	9·29	66·36	9·13
Age 50	0·007556	0·007196	0·008408	0·007075	0·004446	0·007066
percentage s.e.	35·88	6·28	12·72	7·19	49·44	7·07
Age 60	0·015103	0·016309	0·016840	0·016357	0·011397	0·016341
percentage s.e.	23·62	4·49	8·78	5·16	35·19	5·07
Age 70	0·030073	0·036748	0·033583	0·037585	0·029059	0·037556
percentage s.e.	14·01	2·83	5·39	3·25	23·07	3·21
Age 80	0·059428	0·081716	0·066402	0·085145	0·073061	0·085097
percentage s.e.	9·65	1·66	3·77	1·84	13·07	1·81
Age 90	0·115677	0·176427	0·129077	0·186748	0·177316	0·186684
percentage s.e.	13·47	1·90	5·25	1·99	7·57	1·95
Age 100	0·218597	0·357221	0·242686	0·381326	0·394769	0·381275
percentage s.e.	19·81	2·80	7·68	2·97	9·96	2·91
Age 110	0·390386	0·634426	0·428288	0·672217	0·725243	0·672230
percentage s.e.	24·18	3·03	9·32	3·12	10·69	3·06

Table 9.7.

Immediate annuitants, females, Amounts. Statistics for graduations of $\mu_x = \mathrm{GM}(r,s)$

Duration	0	1+	0–4	5+	Pre-1957	Combined
Formula	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)
Values of parameters at optimum point:						
b_1	−4·179001	−4·047361	−4·089408	−4·037878	−3·531460	−4·028245
T-ratio	−26·84	−164·77	−72·09	−149·73	−46·67	−158·15
b_2	4·813591	5·389615	5·336190	5·362681	4·279597	5·340325
T-ratio	10·11	74·47	30·69	68·14	23·34	72·44
Signs test: *p*(pos)	0·2024	0·5000	0·2088	0·2664	0·0877	0·2204
Runs test: *p*(runs)	0·4164	0·9693	0·7465	0·9172	0·7876	0·8956
K–S test: *p*(*KS*)	0·6317	0·2704	0·7991	0·2243	0·5432	0·1316
Serial Correlation test:						
T-ratio 1	0·57	−1·53	−0·21	−1·49	1·12	−1·22
T-ratio 2	−0·75	−0·97	−0·32	−0·60	0·59	−0·50
T-ratio 3	0·14	0·02	−0·22	0·34	−0·16	0·21
χ^2 test:						
χ^2	52·88	218·16	103·22	213·09	105·85	229·01
Degrees of freedom	21	41	36	39	33	40
$p(\chi^2)$	0·0001	0·0000	0·0000	0·0000	0·0000	0·0000
Specimen values of q_x and percentage standard errors.						
Age 20	0·000131	0·000084	0·000085	0·000087	0·000423	0·000090
percentage s.e.	92·71	10·13	25·13	11·09	29·31	10·40
Age 30	0·000342	0·000247	0·000247	0·000255	0·000995	0·000262
percentage s.e.	71·61	8·57	20·94	9·39	24·68	8·80
Age 40	0·000895	0·000727	0·000719	0·000745	0·002341	0·000762
percentage s.e.	54·19	7·03	16·93	7·71	20·27	7·24
Age 50	0·002341	0·002134	0·002089	0·002177	0·005500	0·002217
percentage s.e.	39·63	5·52	13·10	6·05	16·04	5·69
Age 60	0·006120	0·006257	0·006061	0·006349	0·012897	0·006437
percentage s.e.	27·33	4·04	9·45	4·43	11·97	4·17
Age 70	0·015947	0·018276	0·017520	0·018443	0·030089	0·018616
percentage s.e.	17·06	2·62	6·07	2·87	8·09	2·71
Age 80	0·041224	0·052758	0·050091	0·052955	0·069379	0·053210
percentage s.e.	9·82	1·43	3·47	1·56	4·58	1·48
Age 90	0·104386	0·147237	0·138780	0·147024	0·155682	0·147087
percentage s.e.	9·89	1·27	3·46	1·34	2·62	1·25
Age 100	0·250772	0·373768	0·352328	0·371735	0·328526	0·370565
percentage s.e.	14·99	1·94	5·09	2·07	3·92	1·93
Age 110	0·530497	0·747250	0·717157	0·742951	0·608342	0·739985
percentage s.e.	17·32	1·81	4·85	1·96	4·98	1·84

These results confirm the discussion above. For males, pre-1957, and females duration 0, the improvement in the value of L_l is marginally significant, whereas the improvement for females durations 1+, 5+ and Combined 5+ is certainly significant.

The distance between the graduated parameters for the Lives graduations and the corresponding Amounts graduations, in each case using the GM(0,2) formulae, was calculated. The values of D and of $p(D)$ are shown below. The values of D should be compared with a χ^2 distribution.

	Males		Females	
Duration	D	$p(D)$	D	$p(D)$
0	0·06	0·9707	1·83	0·4011
1+	2·76	0·2513	14·72	0·0006
0–4	2·00	0·3678	0·28	0·8675
5+	0·54	0·7621	18·05	0·0001
Pre-1957	3·99	0·1358	0·73	0·6929
Combined 5+	0·36	0·8349	24·96	0·0000

Yet again are the results above confirmed. Only females durations 1+, 5+ and combined 5+ show significant differences between the Lives and the Amounts experiences.

9.7 QUESTIONS FOR THE PROFESSION

(1) The Committee would like to know the profession's views on whether new standard tables for annuitants are required. If there is a demand for one, then the Committee will consider how best to allow for possible forecast improvements in mortality. The method adopted for $a(90)$ and PA(90), of reducing the rates of mortality by one year of age for every 20 calendar years ahead might again be suitable, though the figure of 20 might require to be altered.

(2) Should the table be based on Lives or on Amounts? It has been shown that for males and for the female select experience there is very little difference between the levels of mortality by Lives and by Amounts, whereas for the females ultimate experience the Amounts mortality is some 6% lower than that for Lives. Is it worth paying attention to such a difference, and breaking with the convention of using Lives data? Or is it better to pay attention to the financial consequences and use Amounts data, which makes very little difference for most of the experiences? There is no great difficulty in doing either.

10. RETIREMENT ANNUITANTS, MALES AND FEMALES

10.1 INTRODUCTION

The experience of lives insured under retirement annuities issued under the provisions of the Finance Act 1956 (now Section 226 of the Income and Corporation Taxes Act 1970) has been investigated by the Bureau since 1958, but the Committee has not previously prepared a graduated table based on the experience.

Until now it was mainly the self-employed who effected Section 226 annuities, but a consequence of the Finance (No 2) Act 1987 is that after 1988 these annuities will be treated for tax purposes in the same way as personal pensions approved under the Social Security Act 1986. It is possible that a different class of life will be attracted to the new style of personal pension and also possible that life offices will find difficulty in distinguishing personal pensions effected by the self-employed from those effected by employed persons. The Committee will consult offices about what the best way of dealing with this investigation in future will be.

10.2 THE DATA

The experience for each sex is subdivided by annuities in deferment (deferred) and annuities in the course of payment (vested). It is also of interest to consider the combined experience. The numbers of exposed to risk and of deaths are given below.

	Males		Females	
	Deaths	Central exposed	Deaths	Central exposed
Deferred	12,328	2,997,376·5	860	338,758·0
Vested	8,811	221,898·0	692	35,006·0
Combined	21,139	3,219,274·5	1,552	473,764·0

The usual age ranges are shown below.

	Males			Females		
	Range of data	Exposed ≥ 100	Deaths ≥ 10	Range of data	Exposed ≥ 100	Deaths ≥ 10
Deferred	16–97	18–75	26–75	12–101	20–74	46–69
Vested	26–101	56–89	60–90	29–102	59–85	61–83
Combined	16–101	18–89	26–90	12–102	20–85	46–83

The conditions under which these contracts are issued mean that the very small number of cases recorded at high ages and at very low ages in the deferred data and at low ages in the vested data must be erroneous. The bulk of the data is, however, at the appropriate ages. The conditions of the contracts allow retirement normally at

Table 10.1 *Retirement annuitants, males and females. Comparison of deferred (I) and vested (II) sections.*

	I	II	Numbers						
Sex	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
Males	94·7	108·5	1	26	0·0000	2	0·0741	1,355·0	0·0000
Females	93·8	109·0	2	13	0·0037	4	0·3714	64·4	0·0000

ages between 60 and 75, and there is an adequate number of deaths in both sections of the experience for males from ages 60 to 75 and for females from ages 61 to 69 for comparisons to be valid.

Comparison of the crude rates in the deferred and the vested experiences for each sex shows a very significant difference between the two sections in each case. The results are given in Table 10.1. The crude rates for the deferred section are much lower than those for the vested section. Since in principle a life transfers from the deferred to the vested section at one date, the difference in levels indicates that the annuitants themselves may exercise 'adverse selection' in that they may choose to 'retire', or rather, start drawing their annuity, when they find they are in poor health. In practice the neat concept of one life appearing in one and only one section may be invalidated because one life may have multiple contracts with different offices (multiple contracts within one office are excluded by the rules of the Bureau), may transfer from deferred to vested at a number of different dates, and may transfer to or from a contributing office at vesting.

10.3 THE FEMALE EXPERIENCE

The experience for females proved easier to deal with than that for males. As usual, μ_x was graduated using a GM(r,s) formula. For the deferred section a GM(0,2) formula was satisfactory. This gave a rather large value of χ^2, but a higher order formula did not help, and the high value could be attributed to certain highish values of z_x; the number of deaths was unusually high at age 49, and rather low at ages 63 and 64.

For the vested section and the combined sections a GM(1,2) formula was necessary, and each provided a satisfactory fit. The constant term (a_0) for the vested data was very high, and gave what would normally be thought to be unreasonably high values of q_x when projected to low ages. This reflects the high observed mortality of the small number of cases at ages below 55, which presumably arise because of ill health.

When a GM(1,2) formula was fitted to the deferred section the additional (a_0) parameter was very small and there was very little difference in the results. Summaries of these graduations of the female data are given in Table 10.2.

Table 10.2. *Retirement annuities, females Statistics for graduations of* $\mu_x = \mathrm{GM}(r,s)$

Section	Deferred	Combined	Vested
Formula	GM(0,2)	GM(1,2)	GM(1,2)
Values of parameters at optimum point:			
$100\,a_1$	—	0·031358	0·468864
T-ratio	—	2·78	2·14
b_1	−4·484255	−4·177321	−4·371792
T-ratio	−64·16	−129·26	−21·36
b_2	4·097447	5·368163	5·868739
T-ratio	20·15	28·40	7·07
Signs test: p(pos)	0·2612	0·3417	0·2291
Runs test: p(runs)	0·5419	0·2574	0·4118
K–S test: $p(KS)$	0·9214	0·9984	0·9789
Serial Correlation test:			
T-ratio 1	−0·56	−0·89	−0·47
T-ratio 2	−1·02	−0·68	−0·26
T-ratio 3	0·13	0·59	0·38
χ^2 test:			
χ^2	59·77	71·08	23·93
Degrees of freedom	37	51	26
$p(\chi^2)$	0·0103	0·0330	0·5798
Specimen values of q_x and percentage standard errors.			
Age 20	0·000195	0·000389	0·004715
percentage s.e.	14·68	22·20	37·64
Age 30	0·000443	0·000534	0·004800
percentage s.e.	10·64	14·48	35·74
Age 40	0·001006	0·000960	0·005072
percentage s.e.	6·84	6·93	31·08
Age 50	0·002281	0·002203	0·005952
percentage s.e.	3·73	3·90	21·51
Age 60	0·005169	0·005831	0·008793
percentage s.e.	3·63	2·96	9·29
Age 70	0·011692	0·016371	0·017926
percentage s.e.	6·59	2·97	5·32
Age 80	0·026336	0·046575	0·046889
percentage s.e.	10·18	4·83	6·10
Age 90	0·058768	0·129729	0·134839
percentage s.e.	13·75	7·23	15·00
Age 100	0·128418	0·333667	0·367421
percentage s.e.	16·88	8·75	22·90
Age 110	0·267952	0·694940	0·770207
percentage s.e.	18·67	7·19	17·25

10.4 THE MALE EXPERIENCE

The male experience proved to be less tractable than the female, in that it was not possible to find one order of formula that fitted both the deferred and vested sections and the combined experience reasonably well. For the deferred section the rather high order GM(1,4) formula provided both a good fit and a reasonable shape, except at the highest ages, which are of no importance in this section. A GM(2,2) formula, which seems a plausible one for an experience such as this, produced too few runs, and a considerably higher value of χ^2.

For the combined deferred and vested data a GM(2,2) formula gave a satisfactory fit, but the value of χ^2 was rather large. The higher order formulae GM(0,6) and GM(1,5) had higher values of the L_1 criterion and lower values of χ^2, but did not behave well at the extreme ages.

For the vested section a GM(2,2) formula did indeed provide a good fit, but with parameter values that were beyond reasonable bounds, and a very wide sheaf. A GM(3,0) formula, unusual in being simply a quadratic function of age with no exponential term, provided both a good fit and a reasonable shape. Details of the GM(2,2) formula for all three sections, and of the GM(1,4) and GM(3,0) formulae for the deferred and vested sections are given in Table 10.3. In each case the graduated rates for the combined experience lie close to those for the deferred at lower ages and nearer the vested at higher ages. Over the ages from 60 to 70, where there is a substantial overlap of data, the vested rates are higher than those for the deferred. The same is true for the female experience.

10.5 QUESTIONS FOR THE PROFESSION

(1) The Committee would like to know whether there is any demand for a standard table suitable for retirement annuitants. This may depend on whether one of the other standard tables adequately represents the experience, and on whether the changes in legislation referred to above make it seem likely that there will be a change in the class of life effecting such contracts.

(2) If a standard table is desired, should there be two tables for each sex, based on the deferred and vested sections separately? Is there any practical use for a combined table, which would not represent the experience of either section accurately in the age range over which retirement is permitted, i.e. 60 to 75 under the old rules, and 50 to 75 under the new? A combined table might, however, be useful as a standard of comparison for the Committee.

Table 10.3. *Retirement annuities, males. Statistics for graduations of* $\mu_x = \mathrm{GM}(r,s)$

Section Formula	Deferred GM(2,2)	Combined GM(2,2)	Vested GM(2,2)	Deferred GM(1,4)	Combined GM(2,2)	Vested GM(3,0)
Values of parameters at optimum point:						
$100\,a_1$	−0·836121	−0·229273	−498·232264	0·055957	−0·229273	3·482591
T-ratio	−5·41	−5·99	−0·40	12·81	−5·99	22·58
$100\,a_2$	−0·818572	−0·272096	−237·608620	—	−0·272096	1·468588
T-ratio	−6·03	−6·25	−0·76	—	−6·25	32·87
$100\,a_3$	—	—	—	—	—	3·173248
T-ratio	—	—	—	—	—	20·26
b_1	−3·450599	−3·441139	1·612081	−4·301881	−3·441139	—
T-ratio	−86·51	−223·71	0·65	−5·82	−223·71	—
b_2	3·246045	4·830340	0·502675	8·053773	4·830340	—
T-ratio	15·78	57·70	0·80	4·45	57·70	—
b_3	—	—	—	−0·466764	—	—
T-ratio	—	—	—	−0·64	—	—
b_4	—	—	—	1·463037	—	—
T-ratio	—	—	—	2·80	—	—
Signs test: p(pos)	0·3417	0·1712	0·3258	0·9155	0·1712	0·2257
Runs test: p(runs)	0·0100	0·2024	0·5817	0·6912	0·2024	0·6101
K–S test: $p(KS)$	0·6192	0·3577	0·9465	0·9991	0·3577	0·9910
Serial Correlation test:						
T-ratio 1	2·03	2·13	0·85	0·57	2·13	0·63
T-ratio 2	0·63	1·59	1·02	−0·94	1·59	0·72
T-ratio 3	0·76	0·91	0·46	−0·17	0·91	0·08
χ^2 test:						
χ^2	74·37	114·31	54·76	59·47	114·31	53·72
Degrees of freedom	50	67	40	48	67	41
$p(\chi^2)$	0·0142	0·0003	0·0600	0·1239	0·0003	0·0880

Table 10.3 (*continued*)

Specimen values of q_x and percentage standard errors.

Age 20	0·001018	0·000669	0·341541	0·000560	0·000669	0·398053
percentage s.e.	12·31	11·39	53·81	9·01	11·39	4·82
Age 30	0·000548	0·000562	0·232782	0·000597	0·000562	0·267302
percentage s.e.	13·41	5·72	91·28	6·52	5·72	5·59
Age 40	0·001142	0·001166	0·136022	0·001100	0·001166	0·152302
percentage s.e.	7·25	2·59	174·91	2·63	2·59	6·37
Age 50	0·003772	0·003632	0·063053	0·003726	0·003632	0·067803
percentage s.e.	2·59	1·22	407·58	1·56	1·22	6·97
Age 60	0·010267	0·010961	0·025407	0·010505	0·010961	0·025629
percentage s.e.	1·09	0·90	1049·88	1·33	0·90	4·86
Age 70	0·024042	0·030821	0·031915	0·022705	0·030821	0·031965
percentage s.e.	2·25	0·77	829·86	2·48	0·77	1·66
Age 80	0·051297	0·081940	0·086164	0·046692	0·081940	0·085871
percentage s.e.	4·55	1·49	290·55	14·71	1·49	1·67
Age 90	0·102703	0·204477	0·184645	0·117340	0·204477	0·179509
percentage s.e.	7·12	2·53	121·36	53·56	2·53	2·42
Age 100	0·194662	0·454515	0·316467	0·417316	0·454515	0·300012
percentage s.e.	9·59	3·14	59·67	69·19	3·14	2·72
Age 110	0·346194	0·797784	0·465134	0·994065	0·797784	0·432381
percentage s.e.	11·32	2·39	32·01	29·46	2·39	2·71

11. LIFE OFFICE PENSIONERS, MALES AND FEMALES

11.1 INTRODUCTION

The experience for 1967–70 of pensioners of schemes insured by life offices formed the basis of the Peg1967–70 experience graduation tables on which the PA(90) and PL(90) projected tables were based. The investigation is carried out for both sexes, on the basis both of Lives and of Amounts, and the experience is divided into those who retired at or after their normal pension age (referred to as 'normal') and those who retired before their normal age (referred to as 'early'). In recent years the experience has been subdivided by duration with a ten year select period, but the Committee is not yet satisfied of the accuracy of the data submitted by offices in this respect, and no further reference is made to duration in this Report.

The experience of pensioners for 1979–82 was reported on by the Committee in C.M.I.R. **8**. It was noted that the mortality experienced by normal retirements was below that of PA(90), on an Amounts basis, for both sexes. The PA(90) tables contained an allowance for projection up to the year 1990. It is clear that the improvements in mortality that have occurred since 1967–70 in this experience have been greater than the Committee had forecast. The preparation of new graduated tables on which standard tables can be based is a matter of some urgency.

11.2 THE DATA

The experience is a large one. The total numbers of exposed to risk and of deaths are shown below.

	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
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

The usual age ranges are shown below, based on Lives.

	Males			Females		
	Range of data	Exposed ≥ 100	Deaths ≥ 10	Range of data	Exposed ≥ 100	Deaths ≥ 10
Normal	19–108	54–98	60–100	28–104	55–94	60–95
Early	15–108	45–91	50–92	26–102	49–88	53–88

The entries at the very young ages seem rather implausible. The bulk of the deaths occur above age 60 for normal retirements, and above age 50 for early retirements.

11.3 THE LIVES EXPERIENCE

The graduation of the males normal retirements experience has been discussed fully in Section 16 of the Paper. The formula $\mu_x = \text{GM}(1,3)$ was the most satisfactory low order formula for that experience, and it had a reasonable shape. The same formula was found to be satisfactory also for the females normal retirements.

The experience of early retirements for both sexes shows a relatively high level of mortality below age 50 or so, and the crude rates increase as age reduces. This feature means that a GM(2,2) formula is necessary to fit the experience of both sexes. The higher order formula GM(2,3) is the lowest one with the same parameters as both the GM(1,3) and GM(2,2) formulae, but that allowed too much flexibility in all cases and was not suitable, so no common formula for normals and earlies could be found.

Summaries of the graduations are given in Table 11.1. The values of q_x are seen to be very different for the two sexes (females much lower) and quite different for the two sections (normals lower than earlies over most of the range).

11.4 THE AMOUNTS EXPERIENCE

The experiences by Amounts were graduated using the same formulae as the corresponding experiences by Lives. The numbers of exposed to risk and of deaths were first divided by the average amount per life in the central exposed to risk in each investigation. The average amounts are shown below.

	Males	Females
Normal	324·42	192·30
Early	461·76	227·68

The expected numbers of deaths according to the graduated rates that had been fitted to the corresponding Lives experiences were compared with the actual numbers of deaths, with the following results.

	Actual deaths (units)	Expected deaths (units)	100A/E
Males			
Normal	61,714·1	72,758·6	84·8
Early	17,021·0	20,966·1	81·2
Females			
Normal	7,518·6	8,457·8	88·9
Early	1,309·2	1,515·6	86·4

Table 11.1.

Pensioners, Lives, males and females. Statistics for graduations of $\mu_x = \mathrm{GM}(r,s)$

	Normal or Late		Early	
Sex	Males	Females	Males	Females
Formula	GM(1,3)	GM(1,3)	GM(2,2)	GM(2,2)
Values of parameters at optimum point:				
$100\ a_1$	0·557291	0·662810	−14·141218	−2·005646
T-ratio	3·03	8·12	−2·20	−1·20
$100\ a_2$	—	—	−23·423078	−5·687258
T-ratio	—	—	−3·44	−2·03
b_1	−4·993529	−6·473887	−1·659785	−3·108251
T-ratio	−18·80	−12·69	−4·91	−8·13
b_2	5·882482	8·069982	2·271733	3·838825
T-ratio	21·54	16·00	5·65	5·11
b_3	−1·668855	−2·174915	—	—
T-ratio	−7·74	−4·91	—	—
Signs test: p(pos)	0·5000	0·5000	0·2950	0·6170
Runs test: p(runs)	0·9304	0·9393	0·0310	0·7267
K–S test: $p(KS)$	0·9984	0·9523	0·7737	0·9922
Serial Correlation test:				
T-ratio 1	0·01	−1·37	1·78	−0·02
T-ratio 2	−0·78	1·11	−0·18	0·81
T-ratio 3	−0·42	−1·21	−0·84	−0·44
χ^2 test:				
χ^2	54·72	63·28	80·43	53·68
Degrees of freedom	43	39	51	41
$p(\chi^2)$	0·1085	0·0083	0·0054	0·0886
Specimen values of q_x and percentage standard errors.				
Age 20	0·005561	0·006606	0·104652	0·036562
percentage s.e.	29·24	11·32	18·20	32·19
Age 30	0·005600	0·006608	0·072477	0·026664
percentage s.e.	28·79	11·30	20·51	29·91
Age 40	0·005906	0·006632	0·045502	0·017975
percentage s.e.	25·83	11·05	28·92	28·61
Age 50	0·007729	0·006906	0·027960	0·012051
percentage s.e.	15·73	9·40	48·21	34·09
Age 60	0·015886	0·009095	0·026264	0·012224
percentage s.e.	3·70	4·05	53·99	36·77
Age 70	0·042799	0·021133	0·049543	0·025483
percentage s.e.	0·53	1·52	27·81	18·18
Age 80	0·106334	0·065465	0·109409	0·065808
percentage s.e.	0·52	1·48	10·38	5·65
Age 90	0·209121	0·169280	0·217521	0·158255
percentage s.e.	1·12	2·58	4·61	8·33
Age 100	0·317159	0·313671	0·378788	0·336330
percentage s.e.	3·51	9·04	6·05	14·87
Age 110	0·379986	0·421054	0·579606	0·607540
percentage s.e.	7·94	19·32	7·78	17·47

Table 11.2.

Pensioners, Amounts, males and females. Statistics for graduations of $\mu_x = \mathrm{GM}(r,s)$

	Normal or Late		Early	
Sex	Males	Females	Males	Females
Formula	GM(1,3)	GM(1,3)	GM(2,2)	GM(2,2)
Values of parameters at optimum point:				
$100\ a_1$	0·200555	0·679085	−35·123628	−0·253806
T-ratio	1·60	13·25	−1·72	−0·33
$100\ a_2$	—	—	−42·807425	−1·723064
T-ratio	—	—	−2·87	−1·25
b_1	−4·716394	−7·914792	−0·937945	−3·719774
T-ratio	−19·68	−14·39	−1·80	−10·94
b_2	5·832085	9·365123	1·577428	4·519095
T-ratio	25·04	17·94	3·58	5·36
b_3	−1·277676	−3·358784	–	–
T-ratio	−6·32	−6·83	–	–
Signs test: *p*(pos)	0·5573	0·2307	0·5540	0·1110
Runs test: *p*(runs)	0·9052	0·8815	0·3413	0·2532
K–S test: *p*(*KS*)	0·3557	0·9217	0·8185	0·7215
Serial Correlation test:				
T-ratio 1	−0·36	−1·05	0·56	0·38
T-ratio 2	−0·01	−0·45	−1·73	0·18
T-ratio 3	−2·22	0·46	−1·03	−0·76
χ^2 test:				
χ^2	214·36	466·63	306·48	115·48
Degrees of freedom	44	42	50	39
$p(\chi^2)$	0·0000	0·0000	0·0000	0·0000
Specimen values of q_x and percentage standard errors.				
Age 20	0·002012	0·006768	0·143309	0·014688
percentage s.e.	51·26	6·75	56·34	45·75
Age 30	0·002069	0·006768	0·094732	0·011688
percentage s.e.	49·20	6·75	87·37	40·64
Age 40	0·002426	0·006772	0·054148	0·009270
percentage s.e.	40·18	6·71	156·33	34·83
Age 50	0·004237	0·006866	0·026934	0·008309
percentage s.e.	18·05	6·18	316·60	30·03
Age 60	0·011611	0·008151	0·019971	0·010950
percentage s.e.	2·99	3·34	417·25	22·79
Age 70	0·035405	0·018165	0·041278	0·022403
percentage s.e.	0·54	1·82	187·51	11·52
Age 80	0·094850	0·060719	0·098816	0·054914
percentage s.e.	0·66	1·82	67·06	6·17
Age 90	0·205732	0·151883	0·198003	0·135017
percentage s.e.	1·43	3·44	25·22	11·44
Age 100	0·354160	0·234961	0·337851	0·308422
percentage s.e.	3·91	10·48	10·14	18·36
Age 110	0·492450	0·228110	0·506735	0·603961
percentage s.e.	7·61	24·54	7·73	20·16

In each case the Amounts experience shows considerably lower mortality than the corresponding Lives experience, and the differences were very significant when judged by the appropriate tests, in particular the signs test, and also the serial correlation test. The optimal parameters for each of the Amounts graduations were very different from those of the Lives graduations. The formulae, GM(1,3) for normal retirements and GM(2,2) for early retirements, fitted the Amounts experiences reasonably. The values of χ^2 in every case were high. This result is to be expected if each life does not carry a pension of the same amount; there is every reason to suppose that the amount of pension does in fact vary.

Summaries of each of the graduations of the Amounts experiences are shown in Table 11.2. The graduated rates for Amounts are lower than those for Lives over all ages over age 50, except for males normal, where the Amounts rates exceed the Lives rates above age 92. This covers that part of the age range that is of practical importance.

11.5 QUESTIONS FOR THE PROFESSION

(1) The Committee assumes that a new standard table based on the current experience of pensioners, with a suitable allowance for projected improvements in mortality, would be desired by the profession. As for PA(90), it assumes that a table based on the experience by Amounts for normal retirements for each sex would be the most useful. Is there any demand for a table based on the experience by Lives, as PL(90)?

(2) What is the practical age range desired? The PA(90) tables for females were extended down to age 20 to provide a table for widows' pensions, but it will be seen in Section 13 that the experience of the widows of life office pensioners is considerably higher than that of female pensioners retiring at or after the normal retiring age, and a table particularly for widows may be desired. If so, the practical age range for female pensioners may be more restricted.

(3) There is, however, insufficient experience as yet to construct a table reflecting the mortality of the widowers of female pensioners. But pensions for widowers are now required in many of the circumstances in which widows' pensions are provided. Is there a demand for an extension of the male pensioners' table to younger ages for this purpose?

12. WIDOWS OF LIFE OFFICE PENSIONERS

12.1 DATA INVESTIGATED BY LIVES

The experience for the widows of life office pensioners has been discussed in detail in the Paper. Summary statistics are shown below, including those for the widowers of life office pensioners for whom there is insufficient experience to be worth graduating:

	Widowers	Widows
Deaths	10	692
Central exposed	330·0	28,386·5
Age range	28–87	17–108
Exposed ≥ 100	—	38–86
Deaths ≥ 10	—	59–88

It was shown in the Paper that a simple Gompertz formula, $\mu_x = \mathrm{GM}(0,2)$, would fit the data for widows satisfactorily. Summary statistics for this graduation are shown in Table 12.1.

12.2 DATA INVESTIGATED BY AMOUNTS

The investigation is carried out also on an 'Amounts' basis. The same formula was fitted to the Amounts data, after scaling into units of 559·87, which is the average amount per life in the (central) exposed to risk. The numbers of deaths and central exposed to risk for pensioners' widows are shown below.

		Units of 559·87
Deaths	238,438	426·0
Central exposed	15,892,759·0	28,386·5

On the face of it it appears that the experience by Amounts is much lighter than that by Lives, since deaths amounted to 426·0 Units as compared with 692 lives; the lower figure is 61·6% of the higher. That this ratio is misleading is discussed below.

The same Gompertz formula, $\mu_x = \mathrm{GM}(0,2)$, was fitted to the Amounts data, and Table 12.1 shows also summary results for this graduation. The fit is not quite so good as for the Lives data, the value of $p(\chi^2)$ going down to 0·0056. But this is not surprising for an Amounts experience.

The mortality rates for Amounts are lower than those for Lives at younger ages, but cross at about age 86 and are higher thereafter. When the graduated rates for Lives are applied to the Amounts exposed to risk, the expected number of deaths is found to be 503·7 units; the actual number is 425·9 units, some 84·6% of the

Table 12.1.
Pensioners' widows, 1979–82. Statistics for graduation of μ_x=GM(0,2)

Basis	Lives	Amounts
Values of parameters at optimum point:		
b_0	−3·553013	−3·719382
T-ratio	−90·56	−76·65
b_1	4·316579	4·962087
T-ratio	21·95	20·33
Signs test: p(pos)	0·3776	0·4357
Runs test: p(runs)	0·5124	0·8788
K–S test: $p(KS)$	0·9938	0·6796
Serial Correlation test:		
T-ratio 1	−0·48	0·86
T-ratio 2	0·81	0·01
T-ratio 3	−0·47	1·16
χ^2 test:		
χ^2	38·29	61·13
Degrees of freedom	39	36
$p(\chi^2)$	0·5019	0·0056
Specimen values of q_x and percentage standard errors.		
Age 20	0·000399	0·000178
percentage s.e.	22·98	28·44
Age 30	0·000946	0·000481
percentage s.e.	18·44	22·48
Age 40	0·002242	0·001298
percentage s.e.	14·09	16·88
Age 50	0·005306	0·003497
percentage s.e.	9·97	11·68
Age 60	0·012536	0·009405
percentage s.e.	6·26	7·17
Age 70	0·029468	0·025171
percentage s.e.	3·99	5·00
Age 80	0·068462	0·066462
percentage s.e.	5·20	7·20
Age 90	0·154772	0·169340
percentage s.e.	8·07	10·82
Age 100	0·328796	0·393788
percentage s.e.	10·32	12·90
Age 110	0·611429	0·740835
percentage s.e.	9·99	10·23

expected. When the reverse operation is done, applying the graduated rates for Amounts to the exposed to risk for Lives, the expected number of deaths is 609·6, compared with an actual 692, some 113·5% of the expected; the reciprocal of this ratio is 88·1%

When the average amount per life in the exposed to risk and the average amount per death are calculated at each age, it can be seen that the average amount reduces markedly with age among the exposed to risk, but reduces only gently among the deaths. The average age in the exposed to risk by Amounts is much lower than the average age by Lives. The average amount per death at advanced ages is about the same, or higher, than the average amount per life, whereas at relatively younger ages the average amount per death is very much lower than the average amount per life. This phenomenon accounts for the different gradients of the two sets of graduated rates, and for the contrast between the 'crude' ratio of deaths by Amounts to deaths by Lives of 61·5%, as given above, and the ratios of Amounts to Lives of 84·6% and 88·1%, when standardised in the different ways described above.

From the data available, it is not possible to tell whether this phenomenon will persist into the future. There may be differences between the financial situations of the oldest widows that derive from past history, and which may explain these observations; in this case the differing gradients may not persist. Or it may be that the differential mortality by Amount is in some ways associated with differences in social class, but in fact does not continue into advanced old age; in this case the converging rates may be a permanent feature. This feature was not observed to anything like the same extent in the pensioners' data.

12.3 QUESTIONS FOR THE PROFESSION

(1) The Committee would like to know what the demand might be for a table based specifically on the experience of pensioners' widows. It imagines that either PA(90) or *a*(90) is used, perhaps with adjustment, in the calculation of values of widows' pensions and reversionary annuities. The experience of widows is substantially heavier than either of these tables, and than the corresponding pensioners' and annuitants' experiences, so a different standard table would be justified.

(2) If such a standard table were to be prepared, should it be on a Lives basis, an Amounts basis, or on both? How wide an age range is necessary. The PA(90) tables for females were extended down to age 20 precisely for the purpose of providing rates for widows' pensions. The preparation of a standard table for widows would obviate the need for such an extension for the female pensioners' table. Is this desired by the profession?

13. COMPARISONS OF THE ANNUITANTS EXPERIENCES

13.1 INTRODUCTION

Each of the experiences for annuitants has been considered so far on its own. It may be of interest to compare the various experiences with each other, as has been done from time to time above for the assurances. Tables 13.1 and 13.2 show comparisons in the usual form for males and females respectively, for the following investigations (which include the main assurance investigation):

(1) PA2 Permanent assurances, duration 2+
(2) IA1 Immediate annuities post–1956, lives, duration 1+
(3) RAD Retirement annuities, deferred
(4) RAV Retirement annuities, vested
(5) PNL Pensioners, normal, lives
(6) PNA Pensioners, normal, amounts
(7) PEL Pensioners, early, lives
(8) PEA Pensioners, early, amounts
(9) PWL Pensioners' widows, lives (females only)
(10) PWA Pensioners' widows, amounts (females only)

These tables show a hierarchy of levels of mortality in these experiences, similar for the sexes, which from highest to lowest is, for males:

(1) Pensioners, early, lives
(2=) Pensioners, normal, lives
(2=) Pensioners, early, amounts
(4) Pensioners, normal, amounts
(5=) Retirement annuities, vested
(5=) Permanent assurances, duration 2+
(5=) Immediate annuities, duration 1+
(8) Retirement annuities, deferred

and for females:

(1=) Pensioners' widows, lives
(1=) Pensioners, early, lives
(3=) Pensioners' widows, amounts
(3=) Pensioners, early, amounts
(3=) Pensioners, normal, lives
(6=) Pensioners, normal, amounts
(6=) Immediate annuities, duration 1+

Table 13.1.
Comparison of different experiences, males

Investigations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
PA2	IA1	100·1	98·8	17	26	0·1110	17	0·0953	141·2	0·0000
PA2	RAD	101·2	91·7	41	13	1·0000	14	0·0111	236·3	0·0000
PA2	RAV	99·7	103·0	16	27	0·0631	14	0·0147	1199·2	0·0000
PA2	PNL	94·9	106·1	0	48	0·0000	1	1·0000	1332·5	0·0000
PA2	PNA	98·2	102·8	8	39	0·0000	15	0·7642	335·1	0·0000
PA2	PEL	93·6	135·6	2	50	0·0000	5	1·0000	6283·9	0·0000
PA2	PEA	96·3	126·1	4	46	0·0000	7	0·2298	7690·3	0·0000
IA1	RAD	103·9	98·6	18	0	1·0000	1	1·0000	132·5	0·0000
IA1	RAV	99·0	100·6	16	18	0·4321	20	0·8155	65·2	0·0010
IA1	PNL	81·8	101·3	9	34	0·0001	13	0·2188	312·6	0·0000
IA1	PNA	90·6	100·8	14	29	0·0158	17	0·2033	170·5	0·0000
IA1	PEL	84·4	103·9	5	33	0·0000	8	0·1591	321·9	0·0000
IA1	PEA	92·6	102·3	8	27	0·0009	14	0·6723	117·7	0·0000
RAD	RAV	94·7	108·5	1	26	0·0000	2	0·0741	1355·0	0·0000
RAD	PNL	89·7	101·7	0	22	0·0000	1	1·0000	746·3	0·0000
RAD	PNA	93·4	101·4	3	19	0·0004	4	0·0610	362·7	0·0000
RAD	PEL	77·2	118·2	1	31	0·0000	2	0·0625	5131·2	0·0000
RAD	PEA	82·5	118·1	1	32	0·0000	2	0·0606	7352·3	0·0000
RAV	PNL	81·0	102·5	11	27	0·0069	6	0·0000	598·9	0·0000
RAV	PNA	94·8	100·8	19	19	0·5643	14	0·0349	384·1	0·0000
RAV	PEL	78·9	111·1	13	30	0·0069	6	0·0000	961·2	0·0000
RAV	PEA	90·2	105·9	17	26	0·1110	10	0·0001	353·5	0·0000
PNL	PEL	97·8	109·0	12	30	0·0040	10	0·0020	411·8	0·0000
PNL	PNA	107·0	91·7	39	8	1·0000	12	0·1561	1079·3	0·0000
PNL	PEA	100·4	98·2	24	15	0·9459	16	0·1545	86·2	0·0000
PEL	PNA	124·6	92·9	36	6	1·0000	10	0·2474	2056·1	0·0000
PEL	PEA	109·1	89·6	39	9	1·0000	9	0·0036	510·5	0·0000
PNA	PEA	97·1	111·9	12	27	0·0119	9	0·0011	539·3	0·0000

(1) PA2 Permanent assurances, duration 2+
(2) IA1 Immediate annuities post-1956, lives, duration 1+
(3) RAD Retirement annuities, deferred
(4) RAV Retirement annuities, vested
(5) PNL Pensioners, normal, lives
(6) PNA Pensioners, normal, amounts
(7) PEL Pensioners, early, lives
(8) PEA Pensioners, early, amounts

Table 13.2.
Comparison of different experiences, females

Investigations		I	II	Numbers						
I	v II	A/E	A/E	+	−	$p(+)$	runs	p(runs)	χ^2	$p(\chi^2)$
PA2	IA1	98·1	101·3	11	29	0·0032	13	0·0881	102·0	0·0000
PA2	RAD	101·6	89·5	25	14	0·9734	16	0·1919	76·7	0·0003
PA2	RAV	99·4	105·5	10	18	0·0925	10	0·0798	79·1	0·0000
PA2	PNL	93·2	104·6	5	37	0·0000	11	1·0000	209·3	0·0000
PA2	PNA	96·0	103·7	13	30	0·0069	17	0·2768	1656·4	0·0000
PA2	PEL	92·3	139·0	7	37	0·0000	11	0·2476	755·3	0·0000
PA2	PEA	94·3	141·7	6	33	0·0000	6	0·0040	656·8	0·0000
PA2	PWL	96·6	147·1	5	36	0·0000	11	1·0000	248·9	0·0000
PA2	PWA	98·2	138·0	12	22	0·0607	14	0·2167	153·8	0·0000
IA1	RAD	100·7	92·7	14	0	1·0000	1	1·0000	64·8	0·0000
IA1	RAV	100·6	92·4	21	6	0·9992	12	0·8691	32·3	0·2200
IA1	PNL	94·9	105·3	11	29	0·0032	14	0·1565	133·7	0·0000
IA1	PNA	98·9	101·4	23	16	0·9002	18	0·3221	115·4	0·0000
IA1	PEL	98·1	110·9	7	26	0·0007	8	0·0337	86·3	0·0000
IA1	PEA	99·5	104·2	14	15	0·5000	14	0·3576	54·1	0·0032
IA1	PWL	98·7	122·4	6	27	0·0002	8	0·0812	80·9	0·0000
IA1	PWA	99·4	115·2	12	17	0·2291	15	0·5646	69·2	0·0000
RAD	RAV	93·8	109·0	2	13	0·0037	4	0·3714	64·4	0·0000
RAD	PNL	83·9	101·6	0	16	0·0000	1	1·0000	111·6	0·0000
RAD	PNA	84·8	102·1	2	16	0·0007	5	1·0000	897·0	0·0000
RAD	PEL	71·6	121·9	0	25	0·0000	1	1·0000	583·1	0·0000
RAD	PEA	74·7	128·6	0	24	0·0000	1	1·0000	435·7	0·0000
RAD	PWL	85·7	126·3	0	22	0·0000	1	1·0000	199·8	0·0000
RAD	PWA	90·5	127·0	2	17	0·0004	3	0·1111	133·0	0·0000

RAV	PNL	82·1	101·4	6	22	0·0019	8	0·1266	52·4	0·0034
RAV	PNA	91·2	100·9	10	18	0·0925	17	0·9429	47·4	0·0123
RAV	PEL	80·0	110·0	2	26	0·0000	5	1·0000	76·1	0·0000
RAV	PEA	89·8	106·4	6	22	0·0019	12	0·8560	38·5	0·0889
RAV	PWL	84·0	123·6	4	24	0·0001	6	0·1227	98·1	0·0000
RAV	PWA	90·4	121·0	7	21	0·0063	10	0·2815	82·3	0·0000
PNL	PNA	105·0	93·8	37	4	1·0000	6	0·0596	112·4	0·0000
PNL	PEL	98·4	109·7	13	22	0·0877	8	0·0005	66·9	0·0009
PNL	PEA	99·7	102·6	16	15	0·6399	14	0·2362	51·1	0·0129
PNL	PWL	99·0	119·1	10	25	0·0083	12	0·1182	76·3	0·0001
PNL	PWA	99·6	111·6	16	15	0·6399	17	0·6424	72·0	0·0000
PEL	PNA	119·4	96·1	27	10	0·9962	10	0·0170	215·5	0·0000
PEL	PEA	105·6	92·8	28	10	0·9992	15	0·4626	51·6	0·0700
PEL	PWL	99·1	102·5	17	22	0·2612	17	0·1877	67·0	0·0035
PEL	PWA	102·6	89·7	20	13	0·9186	16	0·4592	134·0	0·0000
PWL	PNA	125·3	98·2	31	6	1·0000	10	0·3037	228·8	0·0000
PWL	PEA	110·0	95·4	25	11	0·9856	10	0·0113	80·6	0·0000
PWL	PWA	106·2	91·4	25	9	0·9985	17	0·9470	35·4	0·4019
PNA	PEA	98·3	111·1	12	21	0·0814	11	0·0344	194·6	0·0000
PNA	PWA	99·4	112·8	11	21	0·0551	18	0·8858	299·1	0·0000
PEA	PWA	100·4	98·7	17	16	0·6358	18	0·6420	111·1	0·0000

(1) PA2 Permanent assurances, duration 2+
(2) IA1 Immediate annuities post-1956, lives, duration 1+
(3) RAD Retirement annuities, deferred
(4) RAV Retirement annuities, vested
(5) PNL Pensioners, normal, lives
(6) PNA Pensioners, normal, amounts
(7) PEL Pensioners, early, lives
(8) PEA Pensioners, early, amounts
(9) PWL Pensioners' widows, lives
(10) PWA Pensioners' widows, amounts

(8=) Retirement annuities, vested
(8=) Permanent assurances, duration 2+
(10) Retirement annuities, deferred

where investigations that are not significantly different are ranked equal. The ratios between the different levels are similar for the two sexes. In some cases the shape of the experiences is different even though the levels are about equal. This can be seen when the numbers of positive and negative signs are not extreme, but the number of runs is too small, for example when retirement annuities, vested, males are compared with permanent assurances or with pensioners, normal, amounts.

14. COMPARISON OF THE GRADUATED RATES

14.1 INTRODUCTION

The graduations of each of the various experiences has been discussed above without comparing the resulting values of q_x. The parameters of each graduation can only practicably be compared where the same order of formula has been used, and it will have been noted that each experience has had to be considered separately and that different orders of formula have been found to be suitable. It is also helpful to be able to compare the graduated rates with those of the existing standard tables.

In order to allow comparisons to be made more readily, the values of q_x for decennial ages from 20 to 110 are therefore repeated in Tables 14.1 to 14.23, along with the values of q_x from the current standard tables. The Tables show:

Males

14.1 Assured lives, A1967–70
14.2 Immediate annuitants, *aeg*1967–70 and *a*(90)
14.3 Pensioners, Peg1967–70, PL(90) and PA(90)
14.4 Assured lives, permanent
14.5 Assured lives, permanent, q_x=LGM(2,2)
14.6 Assured lives, permanent, medical
14.7 Assured lives, permanent, non-medical
14.8 Assured lives, temporary
14.9 Assured lives, linked
14.10 Assured lives, permanent, Ireland
14.11 Immediate annuitants, lives
14.12 Immediate annuitants, amounts
14.13 Retirement annuities
14.14 Pensioners

Females

14.15 Assured lives, FA1975–78
14.16 Immediate annuitants, *aeg*1967–70 and *a*(90)
14.17 Pensioners, Peg1967–70, PL(90) and PA(90)
14.18 Assured lives, permanent
14.19 Assured lives, linked
14.20 Immediate annuitants, lives
14.21 Immediate annuitants, amounts
14.22 Retirement annuities
14.23 Pensioners and widows

Table 14.1 *Male assured lives*, A1967–70

Duration	0	1	2+	2–4	5+
Age 20	0·000662	0·000786	0·000889	0·000880	0·000992
Age 30	0·000438	0·000557	0·000654	0·000608	0·000689
Age 40	0·001016	0·001219	0·001443	0·001386	0·001462
Age 50	0·002862	0·003520	0·004789	0·004152	0·004880
Age 60	0·006699	0·008908	0·014432	0·010647	0·014713
Age 70	0·013631	0·019945	0·039106	0·024018	0·039626
Age 80	0·025312	0·041080	0·097029	0·049674	0·097393
Age 90	0·044126	0·079432	0·216513	0·096034	0·215220
Age 100	0·073307	0·144719	0·412288	0·173747	0·407291
Age 110	0·116809	0·246124	0·638954	0·290620	0·630990

Table 14.2 *Immediate annuitants, males*

Table	*aeg*1967–70		*a*(90)	
Duration	0	1+	0	1+
Age 20	0·000629	0·000889	0·000669	0·000947
Age 30	*0·000462*	*0·000654*	*0·000456*	*0·000646*
Age 40	0·001020	0·001443	0·000898	0·001271
Age 50	0·003384	0·004789	0·002975	0·004209
Age 60	0·010788	0·015266	0·009570	0·013542
Age 70	0·025609	0·037235	0·023412	0·033846
Age 80	0·057150	0·086826	0·052394	0·079295
Age 90	0·122620	0·189465	0·113097	0·174735
Age 100	0·243809	0·364947	0·227262	0·342336
Age 110	—	0·585545	0·404156	0·561347

Table 14.3 *Pensioners, males*

Table	Peg1967–70		P(90)	
Section	Lives	Amounts	Lives	Amounts
Age 50	0·009400	0·007330	0·008575	0·006646
Age 60	0·021569	0·017768	0·019696	0·016127
Age 70	0·048713	0·042437	0·044592	0·038608
Age 80	0·106309	0·097942	0·097817	0·089572
Age 90	0·216504	0·210112	0·201191	0·194221
Age 100	0·390954	0·394559	0·369115	0·371274
Age 110	0·598579	0·614880	0·576113	0·591291

Table 14.4 *Male assured lives, permanent*

Duration	0	1	2	3	4	2–4	1–4	5+	2+
Formula	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)
Age 20	0·000622	0·000807	0·000695	0·000768	0·000867	0·000759	0·000775	0·000867	0·000791
% s.e.	22·83	20·05	14·28	10·83	21·45	6·03	4·86	4·74	3·54
Age 30	0·000424	0·000493	0·000506	0·000550	0·000543	0·000532	0·000522	0·000574	0·000554
% s.e.	34·19	32·75	17·20	10·04	31·96	5·18	4·46	2·66	1·95
Age 40	0·000855	0·001042	0·001109	0·001099	0·001172	0·001129	0·001106	0·001141	0·001141
% s.e.	18·79	17·10	9·56	6·62	16·60	3·27	2·82	1·23	1·09
Age 50	0·002476	0·003170	0·003328	0·003351	0·003614	0·003428	0·003372	0·003859	0·003813
% s.e.	7·03	6·07	4·27	3·57	5·98	1·92	1·66	0·63	0·60
Age 60	0·006333	0·008173	0·008830	0·009359	0·009492	0·009237	0·008998	0·011929	0·011739
% s.e.	4·54	3·86	3·53	3·32	3·42	1·91	1·70	0·53	0·51
Age 70	0·014382	0·018378	0·020948	0·023584	0·021825	0·022223	0·021291	0·033134	0·032718
% s.e.	7·19	6·03	5·87	5·58	5·48	3·25	2·86	0·59	0·58
Age 80	0·030205	0·037884	0·046198	0·055427	0·046110	0·049629	0·046602	0·085510	0·085065
% s.e.	11·22	9·33	9·36	8·96	8·93	5·25	4·57	0·88	0·87
Age 90	0·060190	0·073663	0·096683	0·123387	0·091894	0·105003	0·096541	0·205722	0·206478
% s.e.	15·73	12·98	13·18	12·56	12·76	7·44	6·45	1·29	1·25
Age 100	0·115091	0·136765	0·192489	0·258103	0·174228	0·210623	0·190101	0·442872	0·447742
% s.e.	20·29	16·60	16·68	15·46	16·44	9·39	8·18	1·52	1·45
Age 110	0·210921	0·242281	0·358468	0·488360	0·311969	0·392273	0·350689	0·771310	0·780129
% s.e.	24·18	19·59	18·69	16·00	19·07	10·42	9·27	1·21	1·11

Table 14.5 *Male assured lives, permanent,* q_x=LGM(2,2)

Duration	0	1	2–4	5+	2+
Formula	LGM(2,2)	LGM(2,2)	LGM(2,2)	LGM(2,2)	LGM(2,2)
Age 20	0·000621	0·000806	0·000757	0·000830	0·000769
% s.e.	20·48	26·48	5·48	4·71	3·50
Age 30	0·000424	0·000493	0·000533	0·000574	0·000557
% s.e.	30·45	43·99	4·34	2·62	1·93
Age 40	0·000855	0·001041	0·001127	0·001144	0·001141
% s.e.	16·92	22·55	2·84	1·21	1·07
Age 50	0·002475	0·003170	0·003426	0·003837	0·003790
% s.e.	7·03	7·55	1·79	0·63	0·60
Age 60	0·006335	0·008176	0·009244	0·011930	0·011747
% s.e.	4·50	4·00	1·92	0·53	0·52
Age 70	0·014367	0·018351	0·022203	0·033391	0·032983
% s.e.	7·08	6·39	3·16	0·30	0·60
Age 80	0·030027	0·035974	0·049180	0·085771	0·085261
% s.e.	10·87	10·11	4·92	0·89	0·88
Age 90	0·059149	0·072103	0·101867	0·198815	0·199041
% s.e.	14·94	14·01	6·71	1·21	1·08
Age 100	0·110533	0·130427	0·195757	0·393211	0·395667
% s.e.	18·72	17·54	8·05	1·30	1·24
Age 110	0·194633	0·221320	0·340404	0·627157	0·631734
% s.e.	21·36	19·91	8·40	1·06	0·99

Table 14.10 *Male assured lives, permanent, Ireland*

Duration	0–1	0–1	2+	0–4	0–4	5+	5+
Formula	GM(1,2)	GM(2,2)	GM(2,2)	GM(1,3)	GM(2,2)	GM(2,2)	GM(3,3)
Age 20	0·000624	0·000941	0·001106	0·000663	0·000940	0·001396	0·002351
% s.e.	15·24	73·54	12·95	9·03	47·91	15·25	18·87
Age 30	0·000742	0·000599	0·000683	0·000691	0·000584	0·000782	0·000746
% s.e.	11·32	113·46	7·81	7·88	80·71	10·19	20·04
Age 40	0·001228	0·001106	0·001359	0·001148	0·001290	0·001343	0·001364
% s.e.	10·14	64·83	4·43	9·75	40·34	5·26	18·27
Age 50	0·003225	0·003777	0·004765	0·004352	0·004255	0·004761	0·004923
% s.e.	11·21	21·58	2·18	8·12	13·00	2·39	8·17
Age 60	0·011401	0·011930	0·014901	0·013305	0·011986	0·015069	0·014573
% s.e.	13·19	15·78	1·91	9·79	9·00	2·00	4·40
Age 70	0·044336	0·033784	0·041354	0·020286	0·029673	0·041707	0·042094
% s.e.	22·51	25·59	2·17	26·96	14·81	2·21	3·32
Age 80	0·168688	0·088675	0·105726	0·014538	0·067651	0·105454	0·111682
% s.e.	33·13	42·78	3·28	92·06	23·84	3·35	4·59
Age 90	0·531529	0·216180	0·249154	0·005111	0·144889	0·245094	0·235653
% s.e.	28·61	58·12	4·67	384·97	34·04	4·87	8·87
Age 100	0·955751	0·467298	0·514982	0·001306	0·289732	0·501723	0·371580
% s.e.	8·78	49·14	5·25	1809·04	40·49	5·62	22·68
Age 110	0·999997	0·801567	0·836913	0·000704	0·522278	0·819225	0·448488
% s.e.	0·72	30·07	3·63	3380·04	35·75	4·12	40·51

Table 14.11 *Immediate annuitants, males, lives*

Duration	0	1+	1+	0–4	5+	5+	Pre-1957	Pre-1957	Combined
Formula	GM(0,2)	GM(0,2)	GM(1,3)	GM(0,2)	GM(0,2)	GM(1,3)	GM(0,2)	GM(1,3)	GM(1,3)
Age 20	0·001098	0·000471	0·018445	0·000718	0·000495	0·024137	0·001228	0·065577	0·025743
% s.e.	93·48	12·43	12·39	27·44	14·23	11·65	87·30	12·59	10·20
Age 30	0·002138	0·001120	0·018445	0·001523	0·001174	0·024137	0·002565	0·065577	0·025743
% s.e.	69·32	10·39	12·38	22·28	11·90	11·65	69·03	12·59	10·20
Age 40	0·004159	0·002659	0·018457	0·003232	0·002783	0·024140	0·005357	0·065577	0·025744
% s.e.	50·05	8·39	12·27	17·43	9·62	11·62	53·53	12·59	10·19
Age 50	0·008083	0·006306	0·018646	0·006848	0·006593	0·024212	0·011167	0·065577	0·025796
% s.e.	34·48	6·44	11·45	12·88	7·39	11·26	40·27	12·59	9·96
Age 60	0·015680	0·014918	0·020591	0·014484	0·015574	0·025360	0·023207	0·065577	0·026738
% s.e.	21·91	4·55	7·80	8·71	5·24	8·89	28·80	12·57	8·17
Age 70	0·030309	0·035084	0·033136	0·030499	0·036564	0·035552	0·047910	0·065578	0·036048
% s.e.	12·87	2·83	3·36	5·32	3·25	3·81	18·88	12·41	3·67
Age 80	0·058175	0·081362	0·081927	0·063644	0·084599	0·084081	0·097560	0·068309	0·083721
% s.e.	11·25	1·70	1·63	4·30	1·86	1·84	10·83	13·37	1·86
Age 90	0·110164	0·182617	0·188911	0·130302	0·189222	0·197897	0·193165	0·222234	0·199449
% s.e.	17·04	2·11	1·96	6·32	2·22	2·14	7·22	8·32	2·07
Age 100	0·203316	0·380688	0·308467	0·256507	0·392116	0·311068	0·361594	0·242205	0·312539
% s.e.	24·05	3·03	6·93	8·88	3·26	7·55	9·98	28·46	6·78
Age 110	0·357660	0·679709	0·351038	0·467015	0·693101	0·315692	0·608728	0·069641	0·308922
% s.e.	28·72	3·07	20·50	10·23	3·29	24·40	12·18	110·03	22·63

Table 14.12 *Immediate annuitants, males, amounts*

Duration	0	1+	0–4	5+	Pre-1957	Combined
Formula	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)
Age 20	0·000938	0·000612	0·001037	0·000566	0·000262	0·000565
% s.e.	91·02	11·94	26·19	13·62	111·39	13·38
Age 30	0·001882	0·001392	0·002085	0·001315	0·000673	0·001313
% s.e.	68·77	10·02	21·45	11·44	86·69	11·24
Age 40	0·003773	0·003167	0·004189	0·003052	0·001730	0·003047
% s.e.	50·72	8·13	16·96	9·29	66·36	9·13
Age 50	0·007556	0·007196	0·008408	0·007075	0·004446	0·007066
% s.e.	35·88	6·28	12·72	7·19	49·44	7·07
Age 60	0·015103	0·016309	0·016840	0·016357	0·011397	0·016341
% s.e.	23·62	4·49	8·78	5·16	35·19	5·07
Age 70	0·030073	0·036748	0·033583	0·037585	0·029059	0·037556
% s.e.	14·01	2·83	5·39	3·25	23·07	3·21
Age 80	0·059428	0·081716	0·066402	0·085145	0·073061	0·085097
% s.e.	9·65	1·66	3·77	1·84	13·07	1·81
Age 90	0·115677	0.176427	0.129077	0.186748	0.177316	0.186684
% s.e.	13.47	1.90	5.25	1.99	7.57	1.95
Age 100	0.218597	0.357221	0.242686	0.381326	0.394769	0.381275
% s.e.	19.81	2.80	7.68	2.97	9.96	2.91
Age 110	0.390386	0.634426	0.428288	0.672217	0.725243	0.672230
% s.e.	24.18	3.03	9.32	3.12	10.69	3.06

Table 14.13 *Retirement annuities, males*

Section	Deferred	Deferred	Combined	Vested	Vested
Formula	GM(2,2)	GM(1,4)	GM(2,2)	GM(2,2)	GM(3,0)
Age 20	0·001018	0·000560	0·000669	0·341541	0·398053
% s.e.	12·31	9·01	11·39	53·81	4·82
Age 30	0·000548	0·000597	0·000562	0·232782	0·267302
% s.e.	13·41	6·52	5·72	91·28	5·59
Age 40	0·001142	0·001100	0·001166	0·136022	0·152302
% s.e.	7·25	2·63	2·59	174·91	6·37
Age 50	0·003772	0·003726	0·003632	0·063053	0·067803
% s.e.	2·59	1·56	1·22	407·58	6·97
Age 60	0·010267	0·010505	0·010961	0·025407	0·025629
% s.e.	1·09	1·33	0·90	1049·88	4·86
Age 70	0·024042	0·022705	0·030821	0·031915	0·031965
% s.e.	2·25	2·48	0·77	829·86	1·66
Age 80	0·051297	0·046692	0·081940	0·086164	0·085871
% s.e.	4·55	14·71	1·49	290·55	1·67
Age 90	0·102703	0·117340	0·204477	0·184645	0·179509
% s.e.	7·12	53·56	2·53	121·36	2·42
Age 100	0·194662	0·417316	0·454515	0·316467	0·300012
% s.e.	9·59	69·19	3·14	59·67	2·72
Age 110	0·346194	0·994065	0·797784	0·465134	0·432381
% s.e.	11·32	29·46	2·39	32·01	2·71

Table 14.14 *Pensioners, males*

Section	Normal		Early	
Basis	Lives	Amounts	Lives	Amounts
Formula	GM(1,3)	GM(1,3)	GM(2,2)	GM(2,2)
Age 20	0·005561	0·002012	0·104652	0·143309
% s.e.	29·24	51·26	18·20	56·34
Age 30	0·005600	0·002069	0·072477	0·094732
% s.e.	28·79	49·20	20·51	87·37
Age 40	0·005906	0·002426	0·045502	0·054148
% s.e.	25·83	40·18	28·92	156·33
Age 50	0·007729	0·004237	0·027960	0·026934
% s.e.	15·73	18·05	48·21	316·60
Age 60	0·015886	0·011611	0·026264	0·019971
% s.e.	3·70	2·99	53·99	417·25
Age 70	0·042799	0·035405	0·049543	0·041278
% s.e.	0·53	0·54	27·81	187·51
Age 80	0·106334	0·094850	0·109409	0·098816
% s.e.	0·52	0·66	10·38	67·06
Age 90	0·209121	0·205732	0·217521	0·198003
% s.e.	1·12	1·43	4·61	25·22
Age 100	0·317159	0·354160	0·378788	0·337851
% s.e.	3·51	3·91	6·05	10·14
Age 110	0·379986	0·492450	0·579606	0·506735
% s.e.	7·94	7·61	7·78	7·73

Table 14.15 *Female assured lives,* FA1975–78

Duration	0	1	2+
Age 20	0·000237	0·000240	0·000273
Age 30	0·000318	0·000344	0·000477
Age 40	0·000619	0·000695	0·001071
Age 50	0·001465	0·001674	0·002695
Age 60	0·003758	0·004317	0·007042
Age 70	0·009874	0·011368	0·018728
Age 80	0·026555	0·030761	0·052223
Age 90	0·076182	0·089433	0·159331
Age 100	0·238070	0·280519	0·478119

Table 14.16 *Immediate annuitants, females*

Table	*aeg*1967–70		*a*(90)	
Duration	0	1+	0	1+
Age 20	0·000163	0·000328	0·000177	0·000340
Age 30	0·000212	0·000426	0·000213	0·000409
Age 40	0·000549	0·001105	0·000506	0·000972
Age 50	0·001436	0·002891	0·001377	0·002645
Age 60	0·004156	0·008365	0·003270	0·006280
Age 70	0·011520	0·019712	0·010080	0·018037
Age 80	0·038247	0·054901	0·033579	0·049967
Age 90	0·111292	0·148390	0·098167	0·130889
Age 100	0·230466	0·307288	0·225976	0·301301
Age 110	—	0·439303	0·414397	0·552530

Table 14.17 *Pensioners, females*

Duration	Peg1967–70		P(90)	
Formula	Lives	Amounts	Lives	Amounts
Age 50	0·003127	0·002653	0·002787	0·002354
Age 60	0·008876	0·007839	0·007916	0·006961
Age 70	0·024926	0·022932	0·022271	0·020396
Age 80	0·068013	0·065170	0·061054	0·058243
Age 90	0·172409	0·171548	0·156562	0·155192
Age 100	0·372925	0·380831	0·346361	0·353024
Age 110	0·629315	0·646263	0·602021	0·618432

Table 14.18 *Female assured lives, permanent*

Duration	0	0	1	1	1	1–4	2+	2+	5+	5+
Formula	GM(1,2)	GM(2,2)	GM(1,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(2,2)	GM(1,5)	GM(2,2)	GM(1,5)
Age 20	0·000178	0·000222	0·000219	0·000265	0·000265	0·000260	0·000209	0·000317	0·000214	0·000385
% s.e.	15·16	88·61	14·58	19·91	19·91	12·11	13·20	5·12	24·86	6·79
Age 30	0·000275	0·000222	0·000349	0·000312	0·000312	0·000300	0·000361	0·000335	0·000411	0·000399
% s.e.	7·76	94·59	7·35	16·36	16·36	9·35	4·16	4·42	5·56	5·92
Age 40	0·000536	0·000510	0·000730	0·000699	0·000699	0·000746	0·000867	0·000795	0·000953	0·000869
% s.e.	6·39	43·76	5·49	10·65	10·65	5·32	2·69	4·53	3·52	5·83
Age 50	0·001234	0·001352	0·001852	0·001938	0·001938	0·002084	0·002340	0·002584	0·002472	0·002767
% s.e.	5·91	16·69	4·96	6·82	6·82	3·35	1·83	2·50	2·23	3·15
Age 60	0·003101	0·003249	0·005146	0·005316	0·005316	0·005378	0·006455	0·006147	0·006735	0·006405
% s.e.	6·26	8·88	4·88	6·30	6·30	3·15	1·90	2·35	2·24	2·74
Age 70	0·008089	0·007155	0·014775	0·014020	0·014020	0·012944	0·017741	0·015915	0·018667	0·016736
% s.e.	10·56	12·01	7·92	9·26	9·26	4·86	2·13	2·52	2·53	3·05
Age 80	0·021331	0·014871	0·042574	0·035821	0·035821	0·029748	0·048121	0·051774	0·051595	0·055417
% s.e.	17·01	19·58	12·55	15·28	15·28	8·12	2·87	3·68	3·67	4·67
Age 90	0·055952	0·029747	0·119906	0·088755	0·088755	0·066075	0·126777	0·152626	0·138758	0·146473
% s.e.	24·07	29·82	17·13	22·65	22·65	12·07	4·01	4·71	5·45	11·86
Age 100	0·142806	0·057855	0·313091	0·209531	0·209531	0·141638	0·310770	0·200242	0·344084	0·121023
% s.e.	30·07	42·48	19·25	28·90	28·90	15·99	4·90	14·81	6·76	73·38
Age 110	0·338149	0·109638	0·668726	0·447197	0·447197	0·287402	0·639827	0·037238	0·696113	0·006487
% s.e.	30·81	55·78	14·34	28·70	28·70	18·61	4·46	71·29	5·81	1435·30

Table 14.19 *Female assured lives, linked*

Duration	0	1–4	5+
Formula	GM(1,2)	GM(1,2)	GM(1,2)
Age 20	0·000186	0·000301	0·000543
% s.e.	57·07	69·21	38·75
Age 30	0·000192	0·000592	0·000663
% s.e.	54·66	27·46	27·83
Age 40	0·000230	0·001209	0·001035
% s.e.	44·85	13·34	14·00
Age 50	0·000463	0·002520	0·002180
% s.e.	29·99	9·96	7·53
Age 60	0·001869	0·005302	0·005705
% s.e.	24·80	9·52	6·81
Age 70	0·010340	0·011189	0·016501
% s.e.	17·20	15·81	12·08
Age 80	0·060097	0·023588	0·049075
% s.e.	17·98	27·29	22·35
Age 90	0·312154	0·049429	0·142923
% s.e.	24·40	41·64	32·94
Age 100	0·896051	0·102110	0·377981
% s.e.	10·86	56·34	34·77
Age 110	0·999999	0·204596	0·768625
% s.e.	0·19	64·48	19·51

Table 14.20 *Immediate annuitants, females, lives*

Duration	0	1+	1+	0–4	5+	5+	Pre-1957	Pre-1957	Combined
Formula	GM(0,2)	GM(0,2)	GM(1,3)	GM(0,3)	GM(0,2)	GM(1,3)	GM(0,2)	GM(1,3)	GM(1,3)
Age 20	0·000068	0·000094	0·006125	0·001375	0·000101	0·006814	0·000374	0·003739	0·007001
% s.e.	100·97	9·82	21·07	269·46	10·64	23·57	29·19	141·19	20·96
Age 30	0·000202	0·000274	0·006132	0·001660	0·000292	0·006819	0·000900	0·003762	0·007004
% s.e.	76·71	8·30	20·89	128·02	9·00	23·42	24·60	140·32	20·88
Age 40	0·000597	0·000798	0·006191	0·002357	0·000843	0·006867	0·002162	0·003923	0·007038
% s.e.	57·09	6·81	20·03	65·37	7·38	22·63	20·22	134·39	20·42
Age 50	0·001763	0·002322	0·006592	0·003933	0·002429	0·007224	0·005191	0·004836	0·007338
% s.e.	41·00	5·33	16·68	32·93	5·79	19·37	16·01	106·41	18·01
Age 60	0·005204	0·006750	0·008826	0·007713	0·006992	0·009351	0·012435	0·009020	0·009336
% s.e.	27·67	3·89	8·85	14·29	4·23	10·81	11·97	48·53	10·52
Age 70	0·015304	0·019539	0·018935	0·017737	0·020037	0·019398	0·029638	0·024348	0·019434
% s.e.	16·79	2·51	3·35	4·56	2·74	3·76	8·11	16·14	3·58
Age 80	0·044565	0·055867	0·055456	0·047487	0·056713	0·056326	0·069784	0·068429	0·057363
% s.e.	9·85	1·39	1·24	3·25	1·49	1·34	4·59	4·89	1·29
Age 90	0·126076	0·154213	0·156875	0·144077	0·154999	0·157888	0·159645	0·164623	0·158848
% s.e.	11·38	1·27	1·19	3·99	1·33	1·27	2·56	2·58	1·14
Age 100	0·328578	0·386125	0·358390	0·442999	0·384807	0·352883	0·341767	0·316938	0·339975
% s.e.	16·38	1·91	3·66	9·40	2·02	3·89	3·79	5·42	3·13
Age 110	0·691968	0·758685	0·618936	0·924917	0·753747	0·594126	0·634141	0·485423	0·542964
% s.e.	15·51	1·74	8·52	6·05	1·87	9·61	4·71	17·68	8·58

Table 14.21 *Immediate annuitants, females, amounts*

Duration	0	1+	0–4	5+	Pre-1957	Combined
Formula	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)	GM(0,2)
Age 20	0·000131	0·000084	0·000085	0·000087	0·000423	0·000090
% s.e.	92·71	10·13	25·13	11·09	29·31	10·40
Age 30	0·000342	0·000247	0·000247	0·000255	0·000995	0·000262
% s.e.	71·61	8·57	20·94	9·39	24·68	8·80
Age 40	0·000895	0·000727	0·000719	0·000745	0·002341	0·000762
% s.e.	54·19	7·03	16·93	7·71	20·27	7·24
Age 50	0·002341	0·002134	0·002089	0·002177	0·005500	0·002217
% s.e.	39·63	5·52	13·10	6·05	16·04	5·69
Age 60	0·006120	0·006257	0·006061	0·006349	0·012897	0·006437
% s.e.	27·33	4·04	9·45	4·43	11·97	4·17
Age 70	0·015947	0·018276	0·017520	0·018443	0·030089	0·018616
% s.e.	17·06	2·62	6·07	2·87	8·09	2·71
Age 80	0·041224	0·052758	0·050091	0·052955	0·069379	0·053210
% s.e.	9·82	1·43	3·47	1·56	4·58	1·48
Age 90	0·104386	0·147237	0·138780	0·147024	0·155682	0·147087
% s.e.	9·89	1·27	3·46	1·34	2·62	1·25
Age 100	0·250772	0·373768	0·352328	0·371735	0·328526	0·370565
% s.e.	14·99	1·94	5·09	2·07	3·92	1·93
Age 110	0·530497	0·747250	0·717157	0·742951	0·608342	0·739985
% s.e.	17·32	1·81	4·85	1·96	4·98	1·84

Table 14.22 *Retirement annuities, females*

Section	Deferred	Combined	Vested
Formula	GM(0,2)	GM(1,2)	GM(1,2)
Age 20	0·000195	0·000389	0·004715
% s.e.	14·68	22·20	37·64
Age 30	0·000443	0·000534	0·004800
% s.e.	10·64	14·48	35·74
Age 40	0·001006	0·000960	0·005072
% s.e.	6·84	6·93	31·08
Age 50	0·002281	0·002203	0·005952
% s.e.	3·73	3·90	21·51
Age 60	0·005169	0·005831	0·008793
% s.e.	3·63	2·96	9·29
Age 70	0·011692	0·016371	0·017926
% s.e.	6·59	2·97	5·32
Age 80	0·026336	0·046575	0·046889
% s.e.	10·18	4·83	6·10
Age 90	0·058768	0·129729	0·134839
% s.e.	13·75	7·23	15·00
Age 100	0·128418	0·333667	0·367421
% s.e.	16·88	8·75	22·90
Age 110	0·267952	0·694940	0·770207
% s.e.	18·67	7·19	17·25

Table 14.23 *Pensioners and widows, females*

Section	Normal		Early		Widows	
Basis	Lives	Amounts	Lives	Amounts	Lives	Amounts
Formula	GM(1,3)	GM(1,3)	GM(2,2)	GM(2,2)	GM(0,2)	GM(0,2)
Age 20	0·006606	0·006768	0·036562	0·014688	0·000399	0·000178
% s.e.	11·32	6·75	32·19	45·75	22·98	28·44
Age 30	0·006608	0·006768	0·026664	0·011688	0·000946	0·000481
% s.e.	11·30	6·75	29·91	40·64	18·44	22·48
Age 40	0·006632	0·006772	0·017975	0·009270	0·002242	0·001298
% s.e.	11·05	6·71	28·61	34·83	14·09	16·88
Age 50	0·006906	0·006866	0·012051	0·008309	0·005306	0·003497
% s.e.	9·40	6·18	34·09	30·03	9·97	11·68
Age 60	0·009095	0·008151	0·012224	0·010950	0·012536	0·009405
% s.e.	4·05	3·34	36·77	22·79	6·26	7·17
Age 70	0·021133	0·018165	0·025483	0·022403	0·029468	0·025171
% s.e.	1·52	1·82	18·18	11·52	3·99	5·00
Age 80	0·065465	0·060719	0·065808	0·054914	0·068462	0·066462
% s.e.	1·48	1·82	5·65	6·17	5·20	7·20
Age 90	0·169280	0·151883	0·158255	0·135017	0·154772	0·169340
% s.e.	2·58	3·44	8·33	11·44	8·07	10·82
Age 100	0·313671	0·234961	0·336330	0·308422	0·328796	0·393788
% s.e.	9·04	10·48	14·87	18·36	10·32	12·90
Age 110	0·421054	0·228110	0·607540	0·603961	0·611429	0·740835
% s.e.	19·32	24·54	17·47	20·16	9·99	10·23

MORTALITY IN 1979–82 OF LIVES ASSURED UNDER WHOLE-LIFE AND ENDOWMENT ASSURANCES, ACCORDING TO CAUSE OF DEATH

1. The last report on the mortality of assured lives according to cause of death related to the years 1975–78 and appeared in *C.M.I.R.* **5**, 37. It was confined to male lives under whole-life and endowment assurances, as were earlier similar reports. The present report relates to 1979–82 and includes for the first time the experience of female lives under the same classes of assurance.

2. 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 death 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 proportions of 'cause unknown' cases, which arose either because the office was unable to produce copies of the death certificate, or because consular or foreign certificates were produced which had no space for the cause of death. The product of the cause-specific rate and the adjusted exposed to risk gave the expected deaths by cause, which were calculated for the same age and duration groups as previously. (In the case of all causes combined, the rates of mortality were multiplied by the *unadjusted* exposed to risk to find the expected deaths, since the actual deaths with which they were to be compared included the 'cause unknown' cases.)

3. 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 from 1979 onwards. The cause groups are generally the same as in the last report, although a number of changes in the code numbers and minor changes in the system of coding took place in the course of the change from the *Eighth Revision* used in the last report, to the *Ninth Revision*. A sample investigation indicated that the proportion of cases was trivial where the *Ninth Revision* would result in a change in the cause group. In this report respiratory diseases are shown in separate tables as it was thought that this group might show differences between the respective experiences of the two sexes, although in the event any such differences do not appear to be significant, possibly on account of the smallness of the female data. A further change since the last report is that the subdivision of certain groups of circulatory diseases, according to whether or not hypertension was mentioned on the death certificate, has been discontinued.

4. The assured lives experience excludes industrial business and does not, it is thought, include many members of social classes IV and V. Standardization Factors (SF) have been calculated by reference to figures for Great Britain published with the OPCS volume *Occupational Mortality: Decennial Supplement, Series DS, 1979–80 and 1982–83*, and these are shown in Table 11. Two sets

Table 1. *Actual male deaths reported in* 1979–82 *due to neoplasms, and comparison with deaths expected from these causes according to national male mortality*

		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.	
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	12	27	85	40	21	36	70	28	1	26	8	23	2	14	21	31
1–2	All ages	61	59	274	62	61	44	265	51	3	34	60	87	15	45	90	66
3–4	All ages	102	71	368	81	82	42	281	52	11	93	69	104	29	64	106	77
5 and over	–44	63	64	359	70	40	55	218	58	30	115	176	114	18	65	151	93
	45–59	786	73	2,425	74	606	42	2,216	51	89	120	253	108	229	85	634	78
	60–74	1,001	69	1,502	77	1,027	47	1,699	57	41	69	70	83	454	85	544	82
	75–	458	68	178	71	427	57	187	65	19	78	6	68	405	92	146	90
	All ages	2,308	70	4,464	75	2,100	47	4,320	54	179	97	505	105	1,106	87	1,475	82

		190–192 (SF 103) Malignant neoplasms of nervous system				140–149 and 193–194 (SF 89) Malignant neoplasms of oral cavity, pharynx and endocrine glands				200–208 (SF101) Neoplasms of lymphatic and haematopoietic tissue				140–239 (SF 95) 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.	
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	6	100	19	39	0	(3)	4	20	3	24	22	22	49	32	258	33
1–2	All ages	9	63	95	97	2	26	15	37	7	24	115	58	173	48	1,004	62
3–4	All ages	21	108	107	110	3	28	23	55	25	65	138	72	298	60	1,173	71
5 and over	–44	35	99	249	124	5	43	34	55	58	90	361	93	279	76	1,690	83
	45–59	173	116	496	107	56	65	123	46	218	89	717	94	2,290	64	7,385	68
	60–74	108	114	155	107	42	52	68	58	233	93	330	97	3,109	62	4,669	70
	75–	26	307	3	89	13	43	6	53	106	101	37	94	1,559	72	612	75
	All ages	342	119	903	111	116	55	231	51	615	93	1,445	94	7,237	65	14,356	70

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

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 for the Standardization Factors differ slightly in some cases from the groupings employed in this report, but the Bureau has endeavoured to obtain as close a correspondence as is possible from the information available. Table 11 also shows similar Standardization Factors for females. As the social classification becomes blurred at the higher ages the Standardization Factors are based on national figures for ages 20–64 for males and ages 20–59 for females. The female factors are based on classification according to their own or their husband's social class.

5. The actual deaths by cause experienced in the whole-life and endowment assurance data submitted by those offices making cause-of-death returns, together with the ratios 100 A/E, appear in Tables 1 to 5 for males and Tables 6 to 10 for females. These tables also show, in the heading of the box for each cause-group, the appropriate Standardization Factor (SF) applicable to social classes I, II, III (Non-Manual) and III (Manual) combined, taken from Table 11, as the 100 A/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 the appropriate columns of Table 11. The distribution of assured lives by social class may vary from office to office, and the Bureau has no information about such distribution.

6. A commentary on the results shown in Tables 1 to 10 appears in tabular form in Table 12 for the male experience and in Table 13 for the female. In the female experience many of the cells are, as yet, too small to show significant results.

7. Table 13 also shows a comparison between the 100 A/E ratios for males and females, but this is not a direct comparison between the two experiences, merely a 'comparison of comparisons' where each experience has been compared with the national experience for the same sex; in other words it compares the total effect of all forms of selection. Consideration of any 'all ages' ratios should bear in mind that the age distributions between the two sexes may differ, and that the average duration in the female ultimate experience is lower than in the male experience. It is also thought that the profession would be interested in a direct comparison between the two sexes, and with this in mind the female experience has also been analysed by comparing actual deaths with those expected according to the *male* cause-specific national mortality rates. The 100 A/E ratios are shown in Tables 14 to 18, and a comparison between the male and female assured lives experiences by cause is given in Table 19, where it will be seen that the female mortality was lower wherever there was a significant difference, apart from malignant neoplasms of bone, connective tissue and skin (including breast) and of the genito-urinary system (non-medical section only) as well as all neoplasms combined (non-medical section only); in these cause-groups the females experienced higher mortality.

Table 2. *Actual male deaths reported in* 1979–82 *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	46	32	343	49	15	30	90	38	1	20	10	40	4	11	61	37
1–2	All ages	136	40	810	55	43	37	241	48	2	17	23	45	17	20	158	47
3–4	All ages	202	43	863	57	62	38	238	46	3	18	17	32	38	33	200	59
5 and over	–44	154	50	880	56	49	47	312	58	1	8	24	38	45	59	263	62
	45–59	2,306	62	8,003	70	632	51	2,200	58	47	41	152	44	330	48	1,213	58
	60–74	3,096	69	4,691	77	777	49	1,285	60	51	31	114	52	763	58	1,004	64
	75–	1,631	81	678	90	655	60	269	68	82	85	20	56	1,196	81	380	72
	All ages	7,187	68	14,252	72	2,113	52	4,066	59	181	47	310	47	2,334	66	2,860	62

		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.	
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
0	All ages	2	12	22	25	6	39	18	28	74	28	544	42
1 2	All ages	9	24	68	39	14	39	41	32	221	35	1,341	51
3–4	All ages	21	42	70	40	16	33	69	52	342	40	1,457	53
5 and over	–44	21	46	124	47	24	94	83	59	294	51	1,686	56
	45–59	156	48	490	50	159	55	486	56	3,630	57	12,544	64
	60–74	273	56	369	60	368	60	502	67	5,328	61	7,965	70
	75–	608	81	192	75	462	78	153	72	4,634	77	1,692	77
	All ages	1,058	66	1,175	56	1,013	67	1,224	62	13,886	64	23,887	66

Notes: A = Actual deaths, E = Deaths expected according to 1979-82 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.

Table 3. *Actual male deaths reported in* 1979–82 *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	22	17	22	1	4	13	14	1	33	3	18	6	13	33	18
1–2	All ages	5	12	34	22	6	11	18	10	4	57	17	51	15	14	69	18
3–4	All ages	11	20	46	30	5	7	48	25	2	21	10	31	18	13	104	28
5 and over	–44	12	33	46	22	6	21	32	20	6	80	12	27	24	34	90	22
	45–59	64	24	235	29	90	21	338	27	38	65	82	46	192	26	655	29
	60–74	226	33	324	42	265	26	429	35	58	59	90	73	549	31	843	40
	75–	851	52	295	53	400	44	161	49	62	65	14	41	1,313	50	470	51
	All ages	1,153	44	900	38	761	32	960	32	164	63	198	52	2,078	40	2,058	36

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 4. *Actual male deaths reported in* 1979–82 *due to suicide, accident and violence, and comparison with deaths expected from these causes according to national male mortality*

		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.	
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	21	129	181	75	10	59	63	32	17	74	225	82	48	86	469	66
1–2	All ages	33	94	324	75	21	54	152	39	41	79	437	83	95	75	913	68
3–4	All ages	40	94	260	71	24	47	180	49	47	70	339	70	111	69	779	64
5 and over	–44	63	55	485	62	81	54	438	46	161	86	914	76	305	68	1,837	63
	45–59	130	81	349	68	206	83	475	59	262	84	715	71	598	83	1,539	66
	60–74	55	67	67	54	71	72	100	66	130	81	159	68	256	75	326	64
	75–	13	42	6	52	12	56	0	(8)	110	92	25	59	135	79	31	50
	All ages	261	67	907	63	370	71	1,013	53	663	85	1,813	73	1,294	77	3,733	64

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 5. *Actual male deaths reported in* 1979–82 *from miscellaneous causes, and from all causes combined, and comparison with deaths expected from these causes according to national male mortality*

		001–139 and 487 (SF 79) 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.	
			100		100		100		100		100		100		100		100
Duration	Age group	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E
0	All ages	1	27	5	18	0	(4)	2	8	2	33	15	32	1	9	31	51
1–2	All ages	7	82	13	23	1	10	8	16	4	28	29	30	15	60	51	42
3–4	All ages	10	87	32	59	2	15	8	16	3	15	34	35	10	29	46	37
5 and over	–44	6	35	42	41	1	6	12	13	17	43	84	39	6	17	83	43
	45–59	32	39	84	33	17	20	83	32	127	82	250	51	97	44	301	44
	60–74	36	50	29	30	39	34	76	53	78	86	110	78	183	57	199	48
	75–	31	68	5	30	65	83	16	55	20	153	5	98	178	64	74	74
	All ages	105	48	160	34	122	42	187	36	242	81	449	53	464	54	657	47

		580–589 (SF 88) Nephritis				590–676 (SF 78) Other diseases of the genito-urinary system				240–389 and 680–779 excluding 250, 291, 303, 305 and 571 (SF 77) All other specified causes				All causes (SF 92) (including ill-defined causes not tabulated elsewhere)			
		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.	
			100		100		100		100		100		100		100		100
Duration	Age group	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E
0	All ages	1	34	5	30	0	(2)	0	(9)	4	25	21	15	189	33	1,505	45
1–2	All ages	1	15	11	33	0	(4)	3	17	14	38	66	24	580	44	3,710	56
3–4	All ages	4	44	10	30	2	37	5	29	22	46	79	31	857	47	3,923	59
5 and over	–44	7	71	25	44	3	57	3	10	28	33	206	39	1,051	63	6,210	65
	45–59	29	55	86	53	13	54	35	48	149	54	428	50	7,591	61	24,528	65
	60–74	51	58	81	75	41	67	43	61	217	72	277	70	10,336	61	15,196	69
	75–	119	93	35	78	111	97	45	113	249	87	100	98	8,836	74	3,194	74
	All ages	206	74	227	61	168	82	126	59	643	68	1,011	54	27,814	65	49,128	67

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 6. *Actual female deaths reported in* 1979–82 *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	1	15	11	27	3	67	13	45	0	(8)	10	12	0	(6)	18	36
1–2	All ages	11	69	48	66	5	47	41	80	9	45	68	46	6	46	59	68
3–4	All ages	14	74	40	65	9	68	40	91	10	42	97	79	10	64	42	58
5 and over	–44	0	(2)	29	104	2	156	11	76	7	91	90	101	3	73	25	50
	45–59	18	72	113	80	7	34	82	72	54	125	251	99	22	85	138	93
	60–74	37	103	49	83	18	70	22	49	25	84	42	78	18	77	34	82
	75–	17	97	7	78	3	65	1	41	2	28	1	27	6	106	2	68
	All ages	72	89	198	84	30	57	116	66	88	100	384	96	49	83	199	82

		190–192 (SF 105) Malignant neoplasms of nervous system				140–149 and 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.	
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	0	(1)	3	31	0	(0)	2	56	0	(2)	4	21	5	17	65	26
1–2	All ages	3	154	12	71	0	(1)	0	(6)	4	95	14	44	44	61	264	60
3–4	All ages	0	(2)	14	104	1	81	1	20	2	42	12	48	50	58	262	72
5 and over	–44	1	96	16	123	0	(0)	1	29	3	169	20	86	19	97	202	87
	45–59	3	82	15	71	3	167	4	39	10	162	38	107	120	90	671	87
	60–74	4	145	6	117	2	98	2	57	3	42	23	193	114	83	192	81
	75–	1	(0)	1	(0)	1	(1)	0	(0)	3	119	1	76	38	90	13	59
	All ages	9	117	38	96	6	124	7	40	19	108	82	113	291	87	1,078	86

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 7. *Actual female deaths reported in 1979–82 from diseases of the circulatory system, and comparison with deaths expected from these causes according to national female mortality*

		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.	
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	7	58	27	56	0	(5)	4	22	0	(1)	1	26	3	33	21	48
1–2	All ages	9	34	42	49	1	10	11	35	1	56	4	60	8	39	38	50
3–4	All ages	10	31	25	34	2	16	16	59	1	48	4	71	10	42	39	61
5 and over	–44	1	58	9	47	1	(1)	0	(8)	0	(0)	0	(2)	8	287	28	83
	45–59	15	50	83	50	3	28	23	39	1	47	6	49	7	33	84	70
	60–74	30	43	79	71	6	24	23	60	1	24	5	76	27	63	41	63
	75–	27	58	16	68	12	42	7	50	3	83	1	55	52	89	26	91
	All ages	73	49	187	59	22	34	53	44	5	50	12	53	94	75	179	72

		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.	
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
0	All ages	1	28	2	11	0	(3)	9	65	11	33	64	44
1–2	All ages	4	48	9	27	2	32	10	42	25	34	114	44
3–4	All ages	1	10	5	18	0	(7)	11	55	24	27	100	46
5 and over	–44	1	82	9	61	0	(1)	6	58	11	148	52	59
	45–59	4	43	15	28	4	61	11	29	34	42	222	50
	60–74	5	30	12	45	5	38	15	73	74	43	175	65
	75–	31	100	13	88	18	96	9	99	143	77	72	78
	All ages	41	70	49	45	27	69	41	53	262	59	521	58

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 8. *Actual female deaths reported in* 1979–82 *from diseases of the respiratory system, and comparison with deaths expected from these causes according to national female mortality*

		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.	
			100		100		100		100		100		100		100		100
Duration	Age group	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E
0	All ages	0	(4)	5	30	1	38	1	6	0	(0)	4	125	1	14	10	27
1–2	All ages	1	11	5	17	0	(6)	8	27	1	99	0	(6)	2	12	13	20
3–4	All ages	4	36	6	25	1	14	4	16	0	(1)	2	45	5	25	12	23
5 and over	–44	0	(1)	7	51	0	(1)	2	18	0	(0)	3	102	0	(2)	12	43
	45–59	1	14	12	30	1	10	9	17	0	(1)	6	78	2	11	27	27
	60–74	6	33	10	38	6	42	9	38	1	51	3	94	13	38	22	41
	75-	30	58	6	25	0	(7)	3	84	0	(2)	2	189	30	49	11	38
	All ages	37	48	35	34	7	22	23	25	1	17	14	94	45	39	72	34

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 9. *Actual female deaths reported in* 1979–82 *due to suicide, accident and violence, and comparison with deaths expected from these causes according to national female mortality*

		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.	
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	1	(1)	14	80	0	(2)	13	55	5	233	26	85	6	129	53	74
1–2	All ages	2	98	25	90	5	136	28	70	6	119	40	78	13	121	93	78
3–4	All ages	4	192	16	83	1	25	20	64	4	74	19	49	9	79	55	62
5 and over	–44	3	214	20	95	2	74	22	62	5	157	39	90	10	138	81	81
	45–59	3	126	15	104	4	67	45	123	14	215	54	137	21	141	114	126
	60–74	1	57	3	98	2	66	5	90	8	157	11	127	11	111	19	110
	75–	0	(1)	1	(0)	1	(0)	0	(0)	2	38	5	192	3	48	6	192
	All ages	7	114	39	100	9	74	72	93	29	144	109	116	45	117	220	104

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 10. *Actual female deaths reported in* 1979–82 *from miscellaneous causes, and from all causes combined, and comparison with deaths expected from these causes according to national female mortality*

		001–139 and 487 (SF 87) 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.	
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	0	(0)	0	(5)	0	(1)	0	(5)	2	(1)	2	23	1	49	4	31
1-2	All ages	1	85	5	55	0	(2)	2	23	0	(2)	4	27	3	63	12	54
3-4	All ages	2	150	5	71	0	(2)	1	14	0	(2)	3	24	4	72	6	33
5 and over	-44	0	(0)	5	78	0	(0)	1	24	0	(1)	5	51	2	(1)	1	9
	45–59	2	111	9	85	1	42	4	30	4	95	24	97	2	34	26	77
	60–74	1	55	1	32	0	(4)	3	44	6	208	3	56	5	51	5	32
	75-	0	(1)	1	(1)	0	(3)	0	(1)	0	(0)	0	(0)	7	71	6	124
	All ages	3	55	16	77	1	10	8	31	10	121	32	80	16	61	38	58

		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 79) 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.	
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	0	(1)	0	(4)	2	(1)	0	(6)	1	29	4	12	32	38	213	37
1-2	All ages	0	(1)	2	29	0	(1)	0	(10)	5	64	18	31	99	51	550	54
3-4	All ages	1	61	4	71	0	(1)	1	13	2	22	15	34	100	44	473	57
5 and over	-44	0	(0)	2	52	0	(1)	6	72	2	65	29	70	49	114	423	79
	45–59	1	58	4	41	0	(1)	0	(8)	4	40	26	45	204	74	1,174	75
	60–74	2	74	0	(4)	0	(2)	1	34	11	86	14	67	253	65	460	73
	75-	3	94	1	65	2	105	0	(1)	23	188	3	50	274	83	128	79
	All ages	6	76	7	36	2	36	7	35	40	105	72	57	780	75	2,185	75

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 11. *Factors for standardizing national mortality rates (Great Britain* 1979–80 *and* 1982–83*) according to social class*

$$\frac{100 \times \text{death rate for classes shown}}{\text{death rate for all classes combined}}$$

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	91
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
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. *Summary of the results for males shown in Tables 1 to 5, and comparison of cause of death experience with that of* 1975–78

(1) Cause group I.C.D. Codes (see Tables 1–5 for descriptions)	(2)* Comparison with all causes combined		(3) Apparent duration of initial selection (years)		(4)* Comparison with 1975–78		(5)* Comparison with Standardization Factor (Classes I, II, III (NM) and III (M))		(6)* Comparison with Standardization Factor (Classes I, II and III (NM))	
	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.
150–159	H	H	3	3	—	—	L	L	L	L
160–165	L	L	1	1	—	—	L	L	L	L
170–175	H	H	—	1	H	H	—	—	—	—
179–189	H	H	3	1	—	—	L	L	L	L
190–192	H	H	3	1	—	—	H	H	H	H
140–149+193–194	—	L	—	—	—	—	L	L	L	L
200–208	H	H	3	5	—	H	L	L	—	—
140–239	—	H	3	3	—	H	L	L	L	L
410	H	H	5	5	—	—	L	L	L	L
411–414	L	L	5	5	L	—	L	L	L	L
401–405	L	L	—	—	—	L	L	L	L	L
430–438	—	L	5	3	—	—	L	L	L	L
390–398+420–429	-	L	5	5	H	—	L	L	L	L
415–417+440–459	- -		5	3	—	—	L	L	L	L
390–459	—	—	5	5	—	—	L	L	L	L
480–486	L	L	5	3	—	—	L	L	L	L
490–496	L	L	5	3	—	—	L	L	L	L
460–478+500–519	—	L	—	—	H	H	L	L	—	—
460–486+490–519	L	L	5	3	—	—	L	L	L	L

Table 12 (*continued*)

(1) Cause group I.C.D. Codes (see Tables 1–5 for descriptions)	(2)* Comparison with all causes combined		(3) Apparent duration of initial selection (years)		(4)* Comparison with 1975–78		(5)* Comparison with Standardization Factor (Classes I, II, III (NM) and III (M))		(6)* Comparison with Standardization Factor (Classes I, II and III (NM))	
	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.
E810–825	—	—	0	0	L	L	L	L	—	—
E950–959	—	L	—	3	—	—	L	L	L	L
E800–807 + 826–949 + 960–999	H	H	—	0	—	L	—	H	H	H
E800–999	H	—	0	0	—	L	L	L	—	—
001–139 + 487	L	L	—	—	—	L	L	L	L	L
250	L	L	—	5	—	—	L	L	L	L
291 + 303 + 305 + 571	H	L	5	5	L	L	L	L	L	L
520–579 except 571	L	L	—	0	—	—	L	L	L	L
580–589	—	—	—	5	H	—	L	L	—	L
590—676	H	—	—	5	H	—	—	—	—	—
240–389 + 680–779 except 250, 291, 303, 305, 571	—	L	5	5	—	—	L	L	L	L
All combined	—	—	5	5	H	H	L	L	L	L

* In these columns 'H' or 'L' indicates that the 1979–82 mortality experienced (as measured by the ratio 100 A/E) for a particular cause-group was in general either significantly higher (H) or significantly lower (L) than the criterion indicated in the relevant heading. If neither of the letters H or L appears the comparison in question indicates no significant difference. A dash in Column 3 indicates that the select experience was too small for the effect of initial selection to be assessed.

Table 13. *Summary of the results for females shown in Tables 6 to 10*

(1) Cause group I.C.D. Codes (see Tables 6–10 for descriptions)	(2)* Comparison with all causes combined		(3) Apparent duration of initial selection (years)		(4)* Comparison with Standardization Factor (Classes I, II, III (NM) and III (M))		(5)* Comparison with Standardization Factor (Classes I, II and III (NM))		(6)* Comparison with male experience	
	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.	Med	Non-med.	Med.	Non-med.
150–159	—	—	—	—	—	—	—	—	—	—
160–165	—	—	—	—	L	L	—	—	—	—
170–175	—	H	5	3	—	—	—	—	—	—
179–189	—	—	—	1	—	—	—	—	—	—
190–192	—	—	—	—	—	—	—	—	—	—
140–149+193–194	—	—	—	—	—	—	—	—	—	—
200–208	—	H	—	5	—	—	—	—	—	—
140–239	H	H	5	5	—	L	—	—	H	H
410	L	L	—	—	L	L	L	L	L	L
411–414	L	—	—	—	L	L	L	L	—	L
401–405	—	—		—	L	L	L	L	—	—
430–438	—	—	—	—	—	—	—	—	—	—
390–398+420–429	—	—	—	—	—	—	—	—	—	L
415–417+440–459	—	—	—	—	—	—	—	—	—	—
390–459	L	L	5	3	L	L	L	L	—	L

Table 13 (*continued*)

(1) Cause group I.C.D. Codes (see Tables 6–10 for descriptions)	(2)* Comparison with all causes combined		(3) Apparent duration of initial selection (years)		(4)* Comparison with Standardization Factor (Classes *I, II, III* (NM) and III (M))		(5)* Comparison with Standardization Factor (Classes I, II and III (NM))		(6)* Comparison with male experience	
	Med.	Non-med.	Med.	Non-med.	Med.	Non-med.	Med	Non-med.	Med.	Non-med.
480–486	L	L	—	—	—	—	—	—	—	—
490–496	L	L	—	—	L	L	—	—	—	—
460–478 + 500–519	—	—	—	—	—	—	—	—	—	—
460—486 + 490–519	L	L	—	—	—	—	—	—	—	—
E810–825	—	—	—	—	—	—	—	—	—	H
E950–959	—	—	—	1	—	—	—	—	—	—
E800–807 + 826–949) + 960–999)	H	H	—	—	H	H	H	H	H	H
E800–999	H	H	—	5	H	H	H	H	H	H
001–139 + 487	—	—	—	—	—	—	—	—	—	—
250	L	L	—	—	—	—	—	—	—	—
291 + 303 + 305 + 571	—	—	—	5	—	—	—	—	—	—
520–579 except 571	—	—	—	—	—	—	—	—	—	—
580–589	—	—	—	—	—	—	—	—	—	—
590–676	—	—	—	—	—	—	—	—	—	—
240–389 + 680–779 except 250, 291, 303, 305, 571)	—	—	5	1	—	—	—	—	H	—
All combined	—	—	5	5	L	L	—	L	H	H

* In these columns 'H' or 'L' indicates that the 1979–82 mortality experienced (as measured by the ratio 100 A/E) for a particular cause-group was in general either significantly higher (H) or significantly lower (L) than the criterion indicated in the relevant heading (but see text with reference to comparison with male experience). If neither of the letters H or L appears the comparison in question indicates no significant difference. A dash in column 3 indicates that the select experience was too small for the effect of initial selection to be assessed.

Table 14. *Actual female deaths reported in* 1979–82 *due to neoplasms, and comparison with deaths expected from these causes according to national MALE mortality*

		150–159 Malignant neoplasms of digestive system				160–165 Malignant neoplasms of respiratory system				170–175 Malignant neoplasms of bone, connective tissue and skin				179–189 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	1	8	11	16	3	19	13	16	0	(1)	10	101	0	(4)	18	85
1–2	All ages	11	41	48	41	5	14	41	29	9	474	68	405	6	61	59	161
3–4	All ages	14	43	40	40	9	20	40	32	10	476	97	747	10	86	42	137
5 and over	–44	0	(4)	29	72	2	77	11	38	7	673	90	669	3	270	25	174
	45–59	18	43	113	49	7	12	82	26	54	1,908	251	1,501	22	209	138	239
	60–74	37	56	49	45	18	18	22	13	25	940	42	913	18	74	34	91
	75–	17	65	7	51	3	11	1	7	2	(1)	1	(1)	6	34	2	68
	All ages	72	53	198	50	30	16	116	22	88	1,172	384	1,088	49	92	199	168

		190–192 Malignant neoplasms of nervous system				140–149 and 193–194 Malignant neoplasms of oral cavity, pharynx and endocrine glands				200–208 Neoplasms of lymphatic and haematopoietic tissue				140–239 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.	
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	0	(1)	3	22	0	(1)	2	33	0	(3)	4	14	5	12	65	27
1–2	All ages	3	103	12	50	0	(2)	0	(10)	4	62	14	29	44	47	264	62
3–4	All ages	0	(3)	14	73	1	46	1	11	2	27	12	31	50	45	262	73
5 and over	44	1	72	16	94	0	(0)	1	20	3	115	20	57	19	137	202	120
	45–59	3	53	15	45	3	88	4	21	10	106	38	70	120	86	671	86
	60–74	4	94	6	77	2	55	2	31	3	27	23	122	114	51	192	52
	75–	1	(0)	1	(0)	1	84	0	(1)	3	73	1	47	38	45	13	29
	All ages	9	77	38	65	6	69	7	23	19	70	82	74	291	63	1,078	79

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 15. *Actual female deaths reported in* 1979–82 *from diseases of the circulatory system, and comparison with deaths expected from these causes according to national MALE mortality*

		410 Acute myocardial infarction				411–414 Other forms of ischaemic heart disease				401–405 Hypertensive disease not classified elsewhere				430–438 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	7	19	27	12	0	(14)	4	5	0	(1)	1	13	3	26	21	41
1–2	All ages	9	10	42	11	1	3	11	8	1	32	4	29	8	31	38	42
3–4	All ages	10	10	25	8	2	5	16	14	1	27	4	35	10	33	39	52
5 and over	–44	1	9	9	7	1	27	0	(41)	0	(0)	0	(5)	8	277	28	80
	45–59	15	10	83	10	3	6	23	8	1	23	6	24	7	26	84	57
	60–74	30	15	79	24	6	8	23	20	1	14	5	41	27	46	41	46
	75–	27	34	16	39	12	27	7	31	3	78	1	51	52	86	26	86
	All ages	73	17	187	14	22	13	53	12	5	31	12	27	94	63	179	59

		390–398 and 420–429 Other diseases of the heart				415–417 and 440–459 Other circulatory diseases				390–459 All diseases of the circulatory system (combined)			
		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
0	All ages	1	22	2	8	0	(5)	9	44	11	15	64	16
1–2	All ages	4	37	9	20	2	18	10	28	25	15	114	16
3–4	All ages	1	8	5	13	0	(13)	11	36	24	12	100	17
5 and over	–44	1	56	9	40	0	(1)	6	51	11	53	52	22
	45–59	4	32	15	21	4	35	11	18	34	14	222	16
	60–74	5	23	12	35	5	18	15	36	74	19	175	28
	75–	31	96	13	83	18	73	9	73	143	58	72	58
	All ages	41	60	49	34	27	42	41	32	262	29	521	22

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 16. *Actual female deaths reported in* 1979–82 *from diseases of the respiratory system, and comparison with deaths expected from these causes according to national MALE mortality*

		480–486 Pneumonia				490–496 Bronchitis				460–478 and 500–519 Other respiratory diseases				460–486 and 490–519 All respiratory diseases (combined)			
		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.	
			100		100		100		100		100		100		100		100
Duration	Age group	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E
0	All ages	0	(7)	5	21	1	13	1	3	0	(1)	4	80	1	7	10	17
1–2	All ages	1	7	5	12	0	(17)	8	15	1	51	0	(9)	2	6	13	13
3–4	All ages	4	23	6	17	1	5	4	9	0	(2)	2	29	5	12	12	14
5 and over	–44	0	(1)	7	40	0	(1)	2	14	0	(0)	3	77	0	(3)	12	34
	45–59	1	10	12	21	1	6	9	10	0	(2)	6	47	2	7	27	17
	60–74	6	20	10	23	6	13	9	13	1	22	3	44	13	16	22	18
	75–	30	42	6	18	0	(36)	3	16	0	(4)	2	102	30	27	11	20
	All ages	37	32	35	23	7	7	23	12	1	9	14	55	45	20	72	19

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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 the brackets is E calculated to the nearer integer.

Table 17. *Actual female deaths reported in* 1979–82 *due to suicide, accident and violence, and comparison with deaths expected from these causes according to national MALE mortality*

		E810–E825 Motor vehicle accidents				E950–E959 Suicide				E800–E807, E826–E949, and E960–E999 All other accidental and violent causes				E800–E999 All accidental and violent causes			
		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	1	33	14	21	0	(3)	13	24	5	115	26	34	6	58	53	27
1–2	All ages	2	31	25	24	5	70	28	31	6	59	40	32	13	55	93	29
3–4	All ages	4	65	16	23	1	13	20	29	4	39	19	20	9	38	55	24
5 and over	–44	3	59	20	25	2	31	22	25	5	62	39	34	10	51	81	29
	45–59	3	51	15	42	4	42	45	78	14	119	54	76	21	77	114	69
	60–74	1	28	3	45	2	45	5	61	8	111	11	87	11	73	19	69
	75–	0	(1)	1	(1)	1	(1)	0	(0)	2	39	5	200	3	42	6	169
	All ages	7	45	39	32	9	43	72	47	29	90	109	54	45	65	220	46

Notes: A = Actual deaths, E = Deaths expected according to 1979-82 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.

Table 18. *Actual female deaths reported in* 1979–82 *from miscellaneous causes, and from all causes combined, and comparison with deaths expected from these causes according to national MALE mortality*

		001–139 and 487 Infective and parasitic diseases, including influenza				250 Diabetes mellitus				291, 303, 305 and 571 Cirrhosis of the liver and/or alcoholism				520–579 excluding 571 Diseases of the digestive system other than cirrhosis			
		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.	
			100		100		100		100		100		100		100		100
Duration	Age group	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E
0	All ages	0	(1)	0	(8)	0	(1)	0	(7)	2	168	2	15	1	34	4	22
1–2	All ages	1	52	5	36	0	(2)	2	15	0	(3)	4	17	3	45	12	38
3–4	All ages	2	90	5	46	0	(3)	1	9	0	(3)	3	15	4	51	6	23
5 and over	–44	0	(1)	5	56	0	(1)	1	13	0	(1)	5	28	2	153	1	6
	45–49	2	65	9	50	1	30	4	21	4	67	24	69	2	24	26	54
	60–74	1	31	1	19	0	(5)	3	38	6	148	3	40	5	35	5	22
	75–	0	(2)	1	(1)	0	(3)	0	(2)	0	(0)	0	(0)	7	62	6	106
	All ages	3	34	16	48	1	8	8	22	10	84	32	53	16	45	38	41

		580–589 Nephritis				590–676 Other diseases of the genito-urinary system				240–389 and 680–779 excluding 250, 291, 303, 305 and 571 All other specified causes				All causes (including ill-defined causes not tabulated elsewhere)			
		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.		Med.		Non-med.	
			100		100		100		100		100		100		100		100
Duration	Age group	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E	A	A/E
0	All ages	0	(1)	0	(5)	2	(1)	0	(3)	1	27	4	10	32	21	213	21
1–2	All ages	0	(2)	2	24	0	(1)	0	(5)	5	58	18	27	99	29	550	32
3–4	All ages	1	43	4	58	0	(2)	1	27	2	21	15	30	100	25	473	34
5 and over	–44	0	(0)	2	41	0	(0)	6	213	2	57	29	60	49	75	423	51
	45–59	1	49	4	35	0	(1)	0	(5)	4	38	26	43	204	43	1,174	44
	60–74	2	51	0	(6)	0	(3)	1	25	11	81	14	64	253	34	460	38
	75–	3	55	1	38	2	41	0	(2)	23	193	3	51	274	56	128	52
	All ages	6	51	7	28	2	23	7	49	40	101	72	52	780	44	2,185	44

Notes: A = Actual deaths, E = Deaths expected according to 1979–82 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.

Table 19. *Comparison of the results for females shown in Tables 14 to 18, with those for males in Tables 1 to 5, both based on the national cause-specific mortality rates for males*

(1) Cause Group I.C.D. codes (see Tables 14–18 for descriptions)	(2) Indication as to whether female mortality amongst assured lives was significantly higher (H) or significantly lower (L) than male mortality	
	Med.	Non-med.
150–159	L	L
160–165	L	L
170–175	H	H
179–189	—	H
190–192	—	L
140–149 + 193–194	—	—
200–208	—	L
140–239	—	H
410	L	L
411–414	L	L
401–405	—	—
430–438	—	—
390–398 + 420–429	—	L
415–417 + 440–459	L	L
390–459	L	L
480–486	—	—
490–496	L	L
460–478 + 500–519	—	—
460–486 + 490–519	L	L
E810–825	—	L
E950–959	—	—
E800–807 + 826–949 + 960–999	—	L
E800–999	—	L
001–139 + 487	—	—
250	—	—
291 + 303 + 305 + 571	—	—
520–579 except 571	—	—
580–589	—	—
590–676	—	—
240–389 + 680–779 except 250, 291, 303, 305, 571	—	—
All combined	L	L

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