

CONTINUOUS MORTALITY INVESTIGATION: ANNUITANTS' EXPERIENCE

1. The last note on this subject appeared in *J.I.A.* Vol. LXXI, p. 277 and in *T.F.A.* Vol. XVII, p. 99. That note dealt with the experience for the years up to 1937 inclusive. Some statistics were sent to the contributing offices in September 1946 showing the experience for individual calendar years from 1923 to 1944 inclusive and these statistics are reproduced in Table 1 (p. 133) with the addition of the appropriate figures for the year 1945.

Figures are also given in the table for groups of years. The first three five-year groups are those which were given in the previous note. The last group covers five complete war years and the two-year period 1938-39 provides a link between the earlier periods and the war period.

2. If the results shown in Table 1 are compared with those published in the previous note, several points of difference must be borne in mind.

- (a) The previous note dealt only with durations 5 and over whereas the figures in Table 1 include all durations.
- (b) The deaths were previously compared with those expected by the forecast rates applicable to the appropriate years of experience, i.e. the rates given on pp. 35 and 36 of *The Mortality of Annuity, 1900-1920, Investigation and Tables*. The actual deaths for the five-year period 1933-37, for example, were compared with the expected deaths according to the rates which it was estimated would apply in the year 1935 to all annuitants irrespective of year of entry. The actual deaths in Table 1 are compared with the expected (using select rates at duration 0) according to the $a(f)$ and $a(m)$ tables, i.e. the rates which it was estimated would apply *on the average* to entrants in the year 1925.
- (c) In the previous note, the data for a number of calendar years were grouped, but the results were subdivided into age-groups. In Table 1 the results are given for individual years of experience as well as for groups of years, but there is no subdivision according to age.

3. The previous note drew attention to the fact that over the period 1921-37 as a whole the mortality of female annuitants had shown little sign of improvement, whereas that of male annuitants had improved and had been slightly lighter than was allowed for by the forecast on which the $a(m)$ table was based. Now that statistics are available for a further period of years, it is desirable to consider whether the addition of this subsequent experience throws any fresh light on the trend of mortality among annuitants.

4. While the figures given in Table 1 suggest a general improvement in the mortality of female annuitants, it is more difficult to detect any trend for the males. In any event it is unwise to attempt to draw conclusions from a comparison of actual and expected deaths from year to year for all ages and durations combined. This is of particular importance over the period covered by Table 1, because the marked increase in annuity business which followed the War Loan conversion resulted in a much higher proportion of lives in the short durations for some years after 1932 than in the earlier years. The table on p. 127 gives, for the groups of years shown at the foot of Table 1, the actual and expected deaths (calculated as in Table 1) and the percentage excess of actual over expected deaths separately for durations 0-4 and durations 5

and over. A column is included showing the percentage of deaths at durations 0-4 to those at all durations combined, which reflects the much higher proportion of the experience at short durations between 1933 and 1939.

For females the excess percentages of actual over expected deaths in the table below show that the impression of general improvement in mortality gained from Table 1 applies separately to the experience for durations 0-4 and durations 5 and over. In the case of the males, there is no more indication of general trend than in Table 1 except possibly for durations 0-4.

Years of experience	Durations 0-4				Durations 5 and over				All durations $\frac{A-E}{E}\%$
	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$		Actual deaths	Expected deaths	$\frac{A-E}{E}\%$		
	Females								
1923-27	1229	15*	1265.9	- 2.9	7199	6594.5	+ 9.2	+ 7.2	
1928-32	1476	15	1596.8	- 7.6	8545	7406.5	+ 15.4	+ 11.3	
1933-37	3309	27	3711.7	- 10.8	9078	8244.6	+ 10.1	+ 3.6	
1938-39	1389	26	1580.4	- 12.1	3928	4020.9	- 2.3	- 5.1	
1940-44	2170	15	2356.2	- 7.9	12051	11863.6	+ 1.6	.0	
1923-44	9573		10511.0	- 8.9	40801	38130.1	+ 7.0	+ 3.6	
	Males								
1923-27	793	23*	803.9	- 1.4	2673	2510.5	+ 6.5	+ 4.5	
1928-32	984	24	992.8	- .9	3171	2824.7	+ 12.3	+ 8.8	
1933-37	1780	35	1930.0	- 7.8	3312	3181.2	+ 4.1	- .4	
1938-39	704	30	730.8	- 3.7	1665	1561.1	+ 6.7	+ 3.4	
1940-44	937	17	970.2	- 3.4	4550	4144.2	+ 9.8	+ 7.3	
1923-44	5198		5427.7	- 4.2	15371	14221.7	+ 8.1	+ 4.7	

* The figures in this column are the percentages of deaths at durations 0-4 to total deaths.

5. The table in the preceding paragraph deals with all ages combined and conclusions based upon it must be accepted with reserve. While it would be desirable to trace in detail the experience in small age-groups, attempts to estimate trends would become much more difficult on account of the wider fluctuations in the smaller figures.

The table on p. 128 shows the excess percentage of actual over expected deaths by the $a(f)$ and $a(m)$ tables in four age-groups for all durations combined.

As regards females there seems no reason to suppose that there is any serious danger of drawing wrong conclusions on trends if the experience is examined in two broad age-groups—up to 70, and 71 and over. The trend of the percentages for males shows less consistency from column to column than for females, but it was decided nevertheless to use the same broad age-groups in the further analysis. One reason for choosing these groups is that it enables a broad comparison to be made with the assured lives experience from year to year for ages 71 and over given in the diagram in *J.I.A.* Vol. LXXI, p. 276, and *T.F.A.* Vol. XVII, p. 98, and it was thought that this might be interesting and instructive.

6. Table 2 gives, for age-groups 'up to 70' and '71 and over', the actual and expected deaths for durations 5 and over and the percentage excess of actual deaths over expected for each calendar year of experience from 1923 to 1944. Similar figures for durations 0-4 combined are given in Table 3. The

percentages in Tables 2 and 3 are shown in graphic form in Diagrams 1 to 8 along with five-year moving averages which help to show the trend more clearly. The diagrams for both males and females for durations 5 and over and ages 71 and over also show the percentages applicable to the general population of England and Wales aged 65 and over. In addition, the diagram for males shows the percentages applicable to assured lives aged 71 and over (Diagram C, *J.I.A.* Vol. LXXI and *T.F.A.* Vol. XVII). The use of group rates for comparison over such a wide range of ages is open to criticism but nevertheless it is interesting to note that in the case of female lives there is a marked similarity in the trends for annuitants and the general population.

Years of experience	Age-group -65	Age-group 66-75	Age-group 76-85	Age-group 86-	All ages
Females					
1923-27	- 4.7	+ 7.4	+ 9.5	+ 6.0	+ 7.2
1928-32	+ 1.2	+ 12.2	+ 14.8	+ 6.7	+ 11.3
1933-37	- 17.4	+ .6	+ 8.9	+ 4.8	+ 3.6
1938-39	- 11.0	- 9.3	- .3	- 7.0	- 5.1
1940-44	- 9.6	- 1.8	+ 1.6	+ 1.7	.0
1923-44	- 9.7	+ 1.9	+ 6.9	+ 3.2	+ 3.6
Males					
1923-27	+ 6.0	- 3.2	+ 8.1	+ 9.9	+ 4.5
1928-32	+ 5.0	+ 14.2	+ 7.2	+ 5.4	+ 8.8
1933-37	- 12.7	+ 3.9	- .2	- 1.8	- .4
1938-39	+ 5.3	- 12.0	+ 10.3	+ 13.4	+ 3.4
1940-44	- 6.8	+ 5.8	+ 9.6	+ 10.2	+ 7.3
1923-44	- 2.9	+ 3.2	+ 6.4	+ 6.5	+ 4.7

The fact that the mortality of the general population shows such wide fluctuations from year to year and that these fluctuations are closely reflected in the mortality of annuitants (and also, incidentally, assured lives) emphasizes the difficulty of estimating the nature and incidence of special influences affecting the mortality of annuitants.

7. The figures for females in Tables 2 and 3 and the corresponding diagrams confirm the impression of a general downward trend. To obtain some measure of general trend, straight lines were fitted to the percentages in Tables 2 and 3 for the years 1923-39; this was done by equating the first and second summations of the percentages. The experience of the years after 1939 was not included, because it seems possible that the war may have introduced temporary disturbing influences, especially for males. The very high male mortality in 1940 lends support to this view. It is obvious that the percentages could not progress along straight lines over a long period, and an examination of the tables and diagrams indicates that straight lines cannot represent a satisfactory graduation. It was felt, however, that over a short period straight lines might give a better idea of the trend than could otherwise be obtained, and for what they are worth the results are given on p. 129 in numerical terms and are shown in the diagrams.

These figures confirm a general downward trend in the period 1923-39 for the females and also for the males at ages up to 70 at durations 0-4. The other figures for males show only a slight downward tendency. It is interesting to

find that straight lines fitted to the percentages for durations 5 and over in the years 1923-37 inclusive show in the case of females a slightly upward trend for ages 71 and over, and a downward tendency for ages 70 and under—though less steep than the line based on the data including 1938 and 1939. In the case of the males, straight lines based on the period 1923-37 show a considerably steeper downward trend than for the whole period 1923-39. These results are consistent with the conclusions reached in the previous note, and the fact that the apparent trend is altered materially by the inclusion of an additional two years' experience emphasizes the difficulty of reaching reliable conclusions regarding trend over a short period of years.

Percentages obtained by fitting straight lines to percentages
shown in Tables 2 and 3 from 1923 to 1939

Year	Durations 5 and over		Durations 0-4	
	Ages up to 70	Ages 71 and over	Ages up to 70	Ages 71 and over
Females				
1923	+ 16.5	+ 13.5	- 12.4	+ 3.4
1939	- 4.9	+ 7.2	- 16.1	- 11.3
Males				
1923	+ 2.6	+ 10.1	+ 9.5	- 5.4
1939	+ 1.1	+ 6.7	- 6.9	- 7.0

8. The straight-line trends can be used to make a rough comparison of the changes in mortality which have taken place with the estimated improvement on the basis of the forecast rates given on pp. 35 and 36 of *The Mortality of Annuity, 1900-1920, Investigation and Tables*. The figures given in Table 3 of the previous note are helpful in this connexion. Assuming the age distribution of the business at durations 5 and over to have remained unchanged throughout the whole period 1925-35 and to be equal to the distribution in the 1933-37 experience, a comparison of the expected deaths in 1933-37 on the basis of the forecast rates for 1925 and 1935 respectively gives a measure of the improvement over the business as a whole which was implied by the forecast. In the case of female lives up to age 69, the expected deaths at durations 5 and over in 1933-37 on the 1935 basis showed a reduction of about 7½% compared with the 1925 basis. The percentage fall between 1925 and 1935, measured by the straight line for ages up to 70 at durations 5 and over, was about 11½%. For the older female lives, the percentage fall implied by the forecast was 6% compared with 3½% on the basis of the straight line for ages 71 and over.

This suggests that for the older female lives the rate of improvement has been rather less than was forecast and that the reverse applies in the case of the younger lives.

For males aged 70 and over, the expected deaths at durations 5 and over in 1933-37 according to the forecast rates of mortality for 1935 were a little over 3% less than the expected deaths by the forecast rates for 1925. This compares with a reduction of 2% between 1925 and 1935 on the basis of the line fitted to the 1923-39 data. The corresponding figures for the younger ages are 6% by the forecast and 1% by the straight line. It thus appears that the improvement in male mortality over the period up to 1939 has been considerably less than was forecast.

9. It may be asked how the experience compares with the forecast implied by the $a(f)$ and $a(m)$ tables. It will be remembered that these tables are based on the average rates which it was estimated would apply to lives entering in 1925. If, therefore, the actual deaths grouped for all years of entry combined are compared with the expected deaths according to the $a(f)$ and $a(m)$ tables, one would expect, if the forecast were working out exactly, that for some years after 1925 the actual deaths for annuitants as a whole would be consistently greater than the expected deaths, but that the discrepancy would gradually diminish until by about 1940 (see tables on p. 34 of *The Mortality of Annuitants*, 1900-1920) the actual and expected deaths would be approximately equal, and thereafter the expected would exceed the actual.

The estimate of 1940 as the 'cross-over' date assumes what might be regarded as a normal distribution of business according to duration in force, and the estimate is accordingly upset by the large flow of business since 1932, which would tend to accelerate the cross-over. In fact, it is apparent from Table 1 that no cross-over either for males or females had been established by 1940, which confirms that the improvement in mortality has been less than was assumed in the forecast.

10. The question arises what annuity values should be used in calculating the purchase price for annuities at the present time and in valuing existing annuities. It is felt that the statistics available do not provide a satisfactory foundation for the preparation of new tables and that this question should be deferred until some years of post-war experience have been examined and further investigation has been made into the matters dealt with in the later part of this note. In the meantime the existing tables can be used with adjustments to age.

If the experience had worked out closely in accordance with the forecast, and if it was expected that the same trend would continue in future, a suitable basis for annuities purchased at the present time would be the $a(f)$ and $a(m)$ tables with a deduction of, say, two years from the age. (See *J.I.A.* Vol. LV, p. 160, D. C. Fraser.) In general, the improvement in mortality has been less than was forecast and therefore a smaller deduction would normally be sufficient. In considering what deductions would be appropriate, it is helpful to examine the circumstances under which it would be justifiable to use the $a(f)$ and $a(m)$ tables without adjustment. This course might be justified on any of the following assumptions of present and future mortality:

- (a) if present mortality rates were approximately the same as in 1925 and it seemed likely that the future trend would be in accordance with the trend previously forecast for the years following 1925;
- (b) if present mortality rates were lower than those applicable to 1925 but this was roughly balanced by an expected improvement in mortality less rapid than was previously forecast;
- (c) if present mortality rates were higher than those applicable to 1925 but this was roughly balanced by an expected improvement in mortality more rapid than was previously forecast.

In the light of the figures given earlier in this note, there can be little doubt that the present level of mortality rates is lower than that applicable to 1925, so that the use of the $a(f)$ and $a(m)$ tables without adjustment for the valuing of new annuities at the present time could only be justified if it were thought that the improvement in mortality would be less rapid than was assumed in

the previous forecast, i.e. case (b) above. It must be largely a matter of conjecture what the rate of improvement is likely to be in future, especially as there are a number of new factors which will have a bearing on the matter. For example, the further reduction in interest rates during the war may introduce a different class of annuitant experiencing heavier mortality. On the other hand, the increasing popularity of annuities for a term-certain and for life thereafter may well intensify selection and make for lower mortality rates for lives purchasing ordinary immediate annuities. (An investigation into the mortality of annuitants effecting annuities for a term-certain and for life thereafter is contemplated, but it will be some years before results can be accumulated.)

Having regard to these factors, it would be rash to assume that the rates of mortality experienced by immediate annuities in the future will fall less rapidly than was assumed in the forecast on which the $a(f)$ and $a(m)$ tables were based. It is accordingly recommended that some deductions from age should be made in the case of an average office in fixing the purchase price of new annuities at the present time, but that the deductions should, in general, be less than the two years which would be appropriate if the experience over the past twenty years had worked out closely in accordance with the forecast. It is suggested that suitable deductions would be:

<i>Female lives</i> , up to age 70,	$1\frac{1}{2}$ to 2 years;
over age 70,	1 to $1\frac{1}{2}$ years;
<i>Male lives</i> , all ages,	1 year.

For annuities which will not be entered upon for many years, e.g. deferred annuities and guaranteed annuity options, larger deductions from age may be desirable.

As regards annuities under staff pension schemes, it is possible that the class of life will differ materially from the general body of annuitants and that heavier mortality will be experienced. The offices are now being asked to make returns relating to pension scheme business, but a considerable time must elapse before sufficient data will be accumulated to permit an investigation into this question.

The adjustments to be made by individual offices must, of course, depend on their own experience and the adjustments detailed above are recommended only for offices whose experience is fairly closely in accordance with the experience of all offices combined.

CONSIDERATION OF THE PRINCIPAL FACTORS AFFECTING ANNUITANTS' MORTALITY

11. In the earlier part of this note, the mortality of annuitants over the period 1923-39 has been examined with respect to the changes which have occurred in the experience from year to year, the object being to arrive at a suitable practical basis for use at the present time. The following paragraphs direct attention to the principal factors affecting the mortality of annuitants and give some figures which may help to throw light on some of these factors. It may be convenient to set out briefly what appear to be the principal factors involved although they are well known to actuaries.

(a) *Secular trend.* This trend, which is the result of improvements in social conditions, advance in science, etc., affects the whole population to a

greater or less extent and there is no reason to suppose that its effect on the mortality of annuitants will differ widely from its effect on that of general population.

- (b) *Class selection.* Under this heading are included any forces operating at the date when annuities are effected (excluding temporary initial selection) which affect the mortality experience. One of the principal factors is current economic conditions, which must have some effect on the class of life effecting annuities. For example, many of those who purchased life annuities after the War Loan conversion in 1932 were probably of a different class from those entering the experience previously and likely to be subject to different rates of mortality. The growing popularity of the annuity-certain combined with a deferred life annuity no doubt has its origin in economic conditions and it may have an effect on the mortality experience of life annuitants. Although there is no statistical evidence to prove or disprove the contention, it seems probable that class selection will persist throughout life, and that its intensity may decrease with increasing duration since entry and at the very old ages may, for all practical purposes, be negligible.
- (c) *Temporary initial selection.* This refers primarily to the selection exercised by an annuitant having regard to the state of his or her health at the time when the purchase is contemplated. There is no satisfactory evidence as to how long this selection persists. It seems likely that for the purpose of calculating annuity-values no harm can result from the assumption of a one-year select period, but for purposes of investigating the effect of other factors on the trend of mortality rates this assumption must be examined more closely.

It is well known that the operation of these three factors, as well as other less important influences, complicates the task of the actuary in interpreting mortality statistics, and in order to trace the effect of any one factor it is desirable to eliminate, as far as possible, the effect of the others.

12. Information about the secular trend is obtainable from a study of general population statistics and it is clear from Diagrams 2 and 4 that, over the period 1923-39 at all events, the secular trend of annuitants' mortality rates for ages over 70 appears to follow the corresponding trend for the general population, especially for females.

13. It is more difficult to trace the effect of class selection. For this purpose it is necessary to obtain data applicable to individual years or groups of years of entry, so that the experience of entrants over a short period can be traced throughout the whole of their subsequent lifetimes. Even if the statistics be available for entrants in individual years, the mortality rates inevitably reflect the secular trend and it is impossible without further investigation to say to what extent changes are due to this factor and to what extent they are due to the operation of class selection. The secular changes could be eliminated by comparing the actual deaths with those expected by the rates of mortality experienced by the general population or an appropriate section of the general population. Unfortunately, rates of mortality age by age among the general population for individual calendar years are not available, but, as we have seen, annuitants' mortality rates for ages over 70 at durations 5 and over follow closely the trend for the general population. It appears, therefore, that the secular trend can be largely eliminated by comparing actual deaths among entrants in individual years or groups of years with those expected on the basis

Table 1. All durations

Calendar year	Females			Males		
	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$
1923	1,635	1,472.42	+ 11.0	606	627.27	- 3.4
1924	1,653	1,524.61	+ 8.4	755	655.16	+ 15.2
1925	1,683	1,581.64	+ 6.4	775	673.14	+ 15.1
1926	1,611	1,611.68	.0	651	666.80	- 2.4
1927	1,846	1,670.04	+ 10.5	679	692.05	- 1.9
1928	1,818	1,710.63	+ 6.3	768	714.05	+ 7.6
1929	2,324	1,754.81	+ 32.4	823	736.19	+ 11.8
1930	1,768	1,772.12	- .2	707	758.45	- 6.8
1931	2,029	1,840.53	+ 10.2	965	792.20	+ 21.8
1932	2,082	1,925.25	+ 8.1	892	816.58	+ 9.2
1933	2,147	2,064.87	+ 4.0	866	876.19	- 1.2
1934	2,276	2,235.53	+ 1.8	916	961.76	- 4.8
1935	2,314	2,404.93	- 3.8	1,017	1,037.21	- 1.9
1936	2,740	2,568.64	+ 6.7	1,173	1,097.82	+ 6.8
1937	2,910	2,682.32	+ 8.5	1,120	1,138.21	- 1.6
1938	2,595	2,804.15	- 7.5	1,232	1,175.35	+ 4.8
1939	2,722	2,797.17	- 2.7	1,137	1,116.56	+ 1.8
1940	2,892	2,743.52	+ 5.4	1,270	1,050.88	+ 20.9
1941	2,814	2,795.87	+ .6	1,092	1,034.26	+ 5.6
1942	2,902	2,850.26	+ 1.8	1,072	1,019.39	+ 5.2
1943	2,710	2,893.09	- 6.3	963	1,009.31	- 4.6
1944	2,903	2,937.03	- 1.2	1,090	1,000.54	+ 8.9
1945	2,996	2,985.73	+ .3	1,022	988.08	+ 3.4
1923-27	8,428	7,860.39	+ 7.2	3,466	3,314.42	+ 4.5
1928-32	10,021	9,003.34	+ 11.3	4,155	3,817.47	+ 8.8
1933-37	12,387	11,956.29	+ 3.6	5,092	5,111.19	- .4
1938-39	5,317	5,601.32	- 5.1	2,369	2,291.91	+ 3.4
1940-44	14,221	14,219.77	.0	5,487	5,114.38	+ 7.3

Table 2. Durations 5 and over
Females

Calendar year	Ages up to 70			Ages 71 and over		
	Actual deaths	Expected deaths	$\frac{A-E}{E} \%$	Actual deaths	Expected deaths	$\frac{A-E}{E} \%$
1923	171	171.07	.0	1,248	1,082.51	+15.3
1924	165.5	165.75	— .2	1,266.5	1,120.64	+13.0
1925	209.5	161.30	+29.9	1,228.5	1,166.23	+5.3
1926	135	149.11	— 9.5	1,242	1,191.56	+4.2
1927	176	144.73	+21.6	1,357	1,241.60	+9.3
1928	148	143.62	+3.0	1,405	1,281.92	+9.6
1929	213	144.57	+47.3	1,767	1,318.40	+34.0
1930	166	142.45	+16.5	1,352	1,330.67	+1.6
1931	141	137.84	+2.3	1,585	1,376.53	+15.1
1932	149	133.75	+11.4	1,619	1,396.77	+15.9
1933	132	131.68	+ .2	1,561	1,419.97	+9.9
1934	151	131.66	+14.7	1,557	1,458.33	+6.8
1935	135	133.61	+1.0	1,580	1,496.75	+5.6
1936	132	139.81	— 5.6	1,824	1,547.64	+17.9
1937	156	170.15	— 8.3	1,850	1,615.00	+14.6
1938	183	216.85	—15.6	1,713	1,754.28	— 2.4
1939	221	245.93	—10.1	1,811	1,803.80	+ .4
1940	277	269.16	+2.9	1,995	1,828.71	+9.1
1941	293	293.38	— .1	2,015	1,949.57	+3.4
1942	302	308.34	— 2.1	2,156	2,079.56	+3.7
1943	262	316.54	—17.2	2,124	2,196.95	— 3.3
1944	290	317.18	— 8.6	2,337	2,304.25	+1.4
1923-27	857	791.96	+8.2	6,342	5,802.54	+9.3
1928-32	817	702.23	+16.3	7,728	6,704.29	+15.3
1933-37	706	706.91	— .1	8,372	7,537.69	+11.1
1938-39	404	462.78	—12.7	3,524	3,558.08	— 1.0
1940-44	1,424	1,504.60	— 5.4	10,627	10,359.04	+2.6

Table 2 (continued)

Males

Calendar year	Ages up to 70			Ages 71 and over		
	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$
1923	84	92.98	- 9.7	386	389.78	- 1.0
1924	92	89.16	+ 3.2	524	412.71	+ 27.0
1925	93.5	84.61	+ 10.5	512.5	428.06	+ 19.7
1926	63	75.53	- 16.6	418	422.54	- 1.1
1927	81	71.50	+ 13.3	419	443.66	- 5.6
1928	77	70.33	+ 9.5	511	465.86	+ 9.7
1929	78	72.61	+ 7.4	542	480.78	+ 12.7
1930	67	74.31	- 9.8	465	494.88	- 6.0
1931	80	72.77	+ 9.9	668	514.37	+ 29.9
1932	73	70.68	+ 3.3	610	508.14	+ 20.0
1933	83	70.51	+ 17.7	545	513.58	+ 6.1
1934	82	69.37	+ 18.2	532	536.31	- .8
1935	63	69.67	- 9.6	563	557.23	+ 1.0
1936	73	74.54	- 2.1	635	582.55	+ 9.0
1937	71	88.88	- 20.1	665	618.55	+ 7.5
1938	112	110.43	+ 1.4	734	670.99	+ 9.4
1939	126	120.28	+ 4.8	693	659.41	+ 5.1
1940	145	124.58	+ 16.4	807	644.33	+ 25.2
1941	92	131.08	- 29.8	786	672.56	+ 16.9
1942	147	135.82	+ 8.2	735	695.66	+ 5.7
1943	110	138.00	- 20.3	742	723.17	+ 2.6
1944	136	134.70	+ 1.0	850	744.28	+ 14.2
1923-27	413.5	413.78	- .1	2,259.5	2,096.75	+ 7.8
1928-32	375	360.70	+ 4.0	2,796	2,464.03	+ 13.5
1933-37	372	372.97	- .3	2,940	2,808.22	+ 4.7
1938-39	238	230.71	+ 3.2	1,427	1,330.40	+ 7.3
1940-44	630	664.18	- 5.0	3,920	3,480.00	+ 12.6

Table 3. Durations 0-4
Females

Calendar year	Ages up to 70			Ages 71 and over		
	Actual deaths	Expected deaths	$\frac{A-E}{E} \%$	Actual deaths	Expected deaths	$\frac{A-E}{E} \%$
1923	64	72.76	-12.0	152	146.08	+4.1
1924	63	80.41	-21.7	158	157.81	+1.1
1925	90	88.52	+1.7	155	165.59	-6.4
1926	64	95.85	-33.2	170	175.16	-3.0
1927	109	101.01	+7.9	204	182.70	+11.7
1928	82	101.04	-18.8	183	184.05	-0.6
1929	109	100.90	+8.0	235	190.94	+23.1
1930	75	102.65	-26.9	175	196.35	-10.9
1931	99	111.55	-11.3	204	214.61	-4.9
1932	106	141.02	-24.8	208	253.71	-18.0
1933	142	193.31	-26.5	312	319.91	-2.5
1934	228	250.60	-9.0	340	394.94	-13.9
1935	220	301.17	-27.0	379	473.40	-20.0
1936	289	337.67	-14.4	495	543.52	-8.9
1937	328	337.74	-2.9	576	559.43	+3.0
1938	261	310.18	-15.9	438	522.84	-16.2
1939	233	273.99	-15.0	457	473.45	-3.5
1940	225	232.62	-3.3	395	413.03	-4.4
1941	169	193.87	-12.8	337	359.05	-6.1
1942	131	158.51	-17.4	313	303.85	+3.0
1943	114	127.85	-10.8	210	251.75	-16.6
1944	96	104.30	-8.0	180	211.30	-14.8
1923-27	390	438.55	-11.1	839	827.34	+1.4
1928-32	471	557.16	-15.4	1,005	1,039.66	-3.3
1933-37	1,207	1,420.49	-15.0	2,102	2,291.20	-8.3
1938-39	494	584.17	-15.4	895	996.29	-10.2
1940-44	735	817.15	-10.1	1,435	1,538.98	-6.8

Table 3 (continued)
Males

Calendar year	Ages up to 70			Ages 71 and over		
	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$	Actual deaths	Expected deaths	$\frac{A-E}{E}\%$
1923	49	45.73	+ 7.2	87	98.78	- 11.9
1924	55	50.74	+ 8.4	84	102.55	- 18.1
1925	71	55.79	+ 27.3	98	104.68	- 6.4
1926	59	60.28	- 2.1	111	108.45	+ 2.4
1927	60	62.42	- 3.9	119	114.47	+ 4.0
1928	64	62.68	+ 2.1	116	115.18	+ .7
1929	73	63.08	+ 15.7	130	119.72	+ 8.6
1930	67	65.39	+ 2.5	108	123.87	- 12.8
1931	75	72.25	+ 3.8	142	132.81	+ 6.9
1932	77	87.31	- 11.8	132	150.45	- 12.3
1933	99	112.24	- 11.8	139	179.86	- 22.7
1934	124	139.39	- 11.0	178	216.69	- 17.9
1935	157	161.18	- 2.6	234	249.13	- 6.1
1936	215	172.12	+ 24.9	250	268.61	- 6.9
1937	133	164.45	- 19.1	251	266.33	- 5.8
1938	141	145.73	- 3.2	245	248.20	- 1.3
1939	117	121.70	- 3.9	201	215.17	- 6.6
1940	111	99.65	+ 11.4	207	182.32	+ 13.5
1941	66	80.76	- 18.3	148	149.86	- 1.2
1942	80	64.16	+ 24.7	110	123.75	- 11.1
1943	36	46.46	- 22.5	75	101.68	- 26.2
1944	38	36.35	+ 4.5	66	85.21	- 22.5
1923-27	294	274.96	+ 6.9	499	528.93	- 5.7
1928-32	356	350.71	+ 1.5	628	642.03	- 2.2
1933-37	728	749.38	- 2.9	1,052	1,180.62	- 10.9
1938-39	258	267.43	- 3.5	446	463.37	- 3.7
1940-44	331	327.38	+ 1.1	606	642.82	- 5.7

Table 4. Percentages of actual to expected deaths based on mortality rates experienced at durations 5 and over by all annuitants in the appropriate calendar year of experience

Females

Year of entry (approx.)	Duration in force					
	0	1	2	3	4	0-4
1920-21	76.3	104.8	68.6	98.1	96.2	88.9
1921-22	83.7	83.2	74.4	63.0	72.8	75.0
1922-23	85.1	68.5	83.9	94.7	112.3	89.8
1923-24	62.0	86.1	72.7	97.7	81.9	80.9
1924-25	64.8	80.7	98.9	93.9	72.7	81.9
1925-26	71.9	81.9	91.2	90.6	76.2	83.2
1926-27	58.9	67.1	70.9	70.1	90.5	72.1
1927-28	61.7	86.4	88.4	84.1	77.1	80.2
1928-29	55.9	79.8	85.4	88.0	99.3	81.1
1929-30	41.5	61.6	60.1	79.2	76.2	66.3
1930-31	51.9	49.1	88.8	84.1	72.4	69.4
1931-32	37.2	62.5	63.6	52.7	68.6	57.1
1932-33	57.0	87.4	91.5	97.6	98.7	87.3
1933-34	65.8	74.9	80.9	86.3	85.3	79.0
1934-35	51.5	74.4	102.4	99.5	105.6	87.8
1935-36	71.4	84.4	83.7	90.1	95.9	85.6
1936-37	61.0	82.4	90.0	90.5	95.6	84.5
1937-38	54.0	88.4	79.8	70.2	89.7	77.0
1938-39	63.2	81.3	89.6	95.6	105.8	87.6
1920-25	73.5	83.5	81.2	90.2	86.4	83.2
1925-30	56.8	75.7	80.0	83.1	83.9	76.4
1930-35	53.5	72.6	86.1	85.6	88.6	77.9
1935-39	62.9	84.2	85.6	86.6	96.1	83.7
1920-39	59.4	77.8	84.2	86.1	89.5	80.0

Note errors due to census method for entrants in 1931-32 and 1932-33 (see *J.I.A.* Vol. LXIX, p. 136, etc.).

Table 4 (continued)

Males

Year of entry (approx.)	Duration in force					
	0	1	2	3	4	0-4
1920-21	63.1	108.4	87.2	55.3	84.6	79.4
1921-22	83.1	93.9	111.3	80.0	97.9	93.5
1922-23	79.2	58.2	99.9	119.6	107.0	91.6
1923-24	54.6	106.6	96.9	130.0	83.4	92.7
1924-25	69.0	74.1	122.9	104.6	109.0	96.4
1925-26	106.7	84.9	85.5	122.9	133.5	107.0
1926-27	56.0	88.9	63.9	117.1	78.4	80.6
1927-28	59.4	87.6	82.7	75.1	71.3	75.2
1928-29	65.6	68.7	86.7	86.3	64.4	75.0
1929-30	52.5	74.3	101.3	94.1	74.9	80.7
1930-31	70.9	71.2	64.7	64.1	112.4	76.2
1931-32	35.1	44.1	57.1	75.3	81.3	58.4
1932-33	59.8	95.8	102.9	120.5	90.4	93.7
1933-34	69.3	94.9	105.5	86.0	103.5	92.2
1934-35	72.4	87.6	116.0	91.5	108.3	95.2
1935-36	62.4	79.7	91.8	84.0	97.7	84.0
1936-37	64.1	63.1	85.8	90.3	88.8	79.1
1937-38	57.0	83.8	94.1	92.0	107.2	87.0
1938-39	55.5	77.9	84.0	82.9	67.5	74.0
1920-25	68.9	85.9	104.5	100.1	96.8	91.3
1925-30	66.3	80.3	85.0	96.3	81.4	82.3
1930-35	61.0	79.8	91.6	91.0	98.1	84.4
1935-39	60.2	75.6	89.4	87.5	92.6	81.5
1920-39	63.1	79.9	91.7	92.7	93.2	84.4

Note errors due to census method for entrants in 1931-32 and 1932-33 (see *J.I.A.* Vol. LXIX, pp. 136, etc.).

Continuous Mortality Investigation

Diagram 1. Ages up to 70, durations 5 and over.

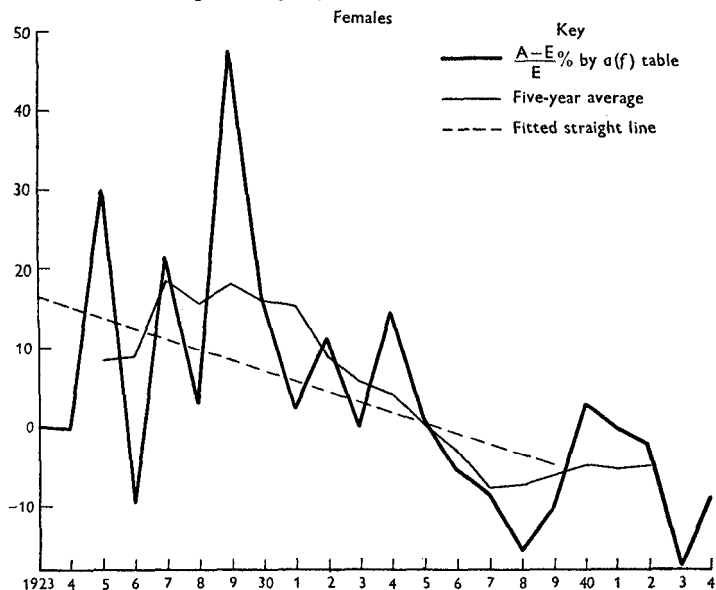


Diagram 2. Ages 71 and over, durations 5 and over.

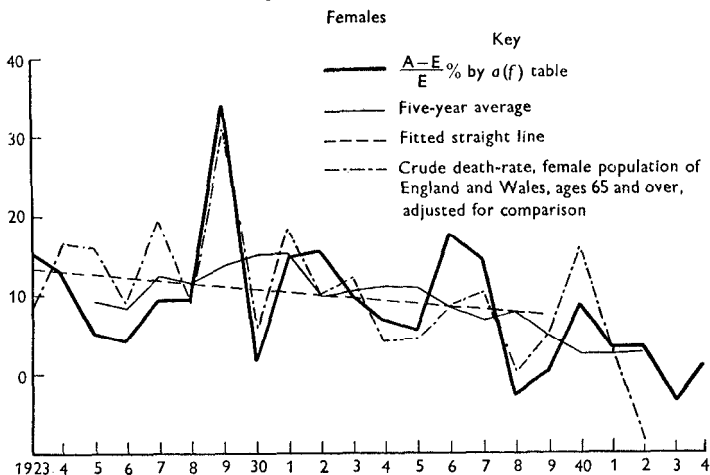


Diagram 3. Ages up to 70, durations 5 and over.

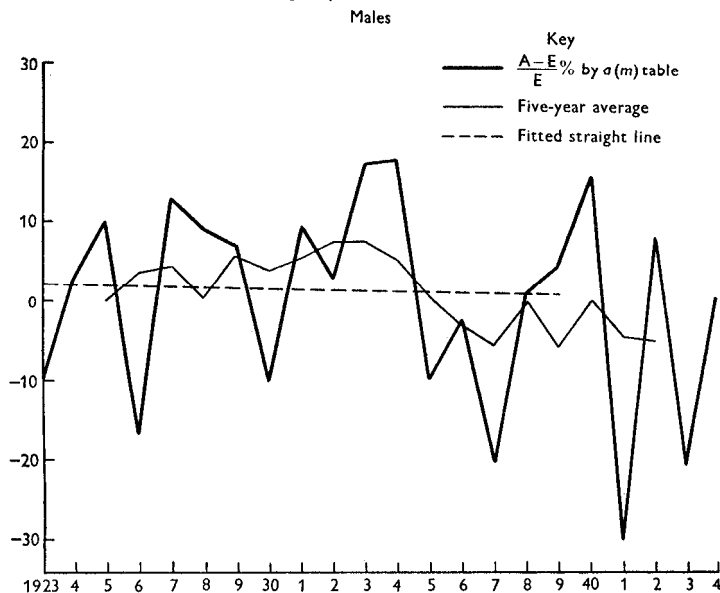
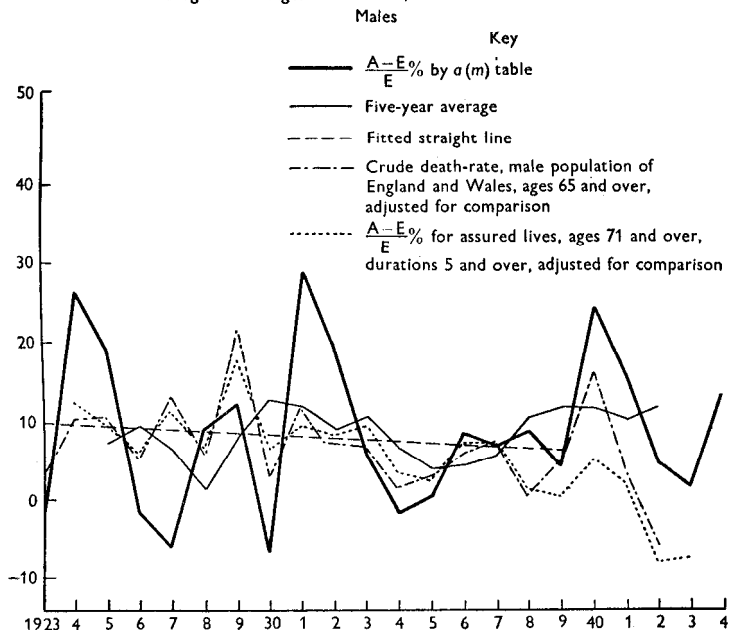


Diagram 4. Ages 71 and over, durations 5 and over.



Continuous Mortality Investigation

Diagram 5. Ages up to 70, durations 0-4.

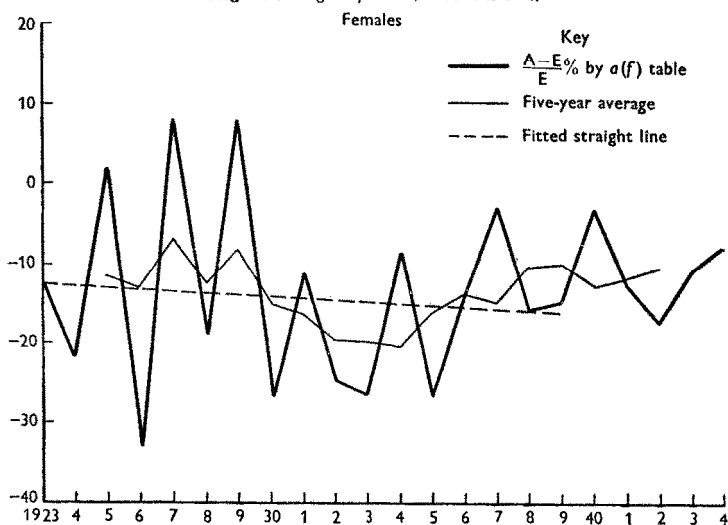


Diagram 6. Ages 71 and over, durations 0-4

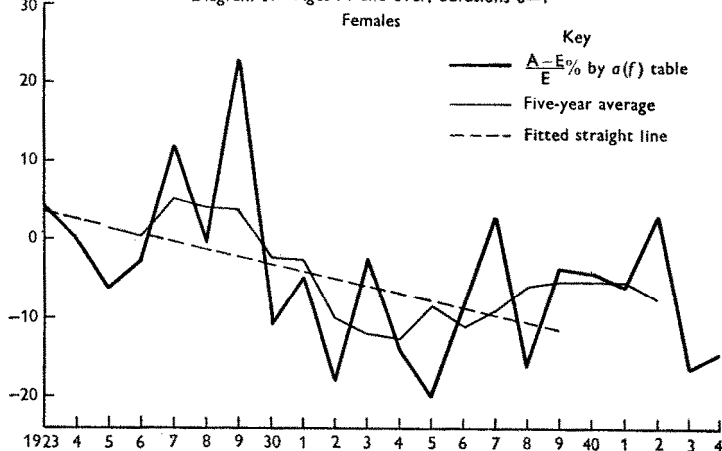


Diagram 7. Ages up to 70, durations 0—4.

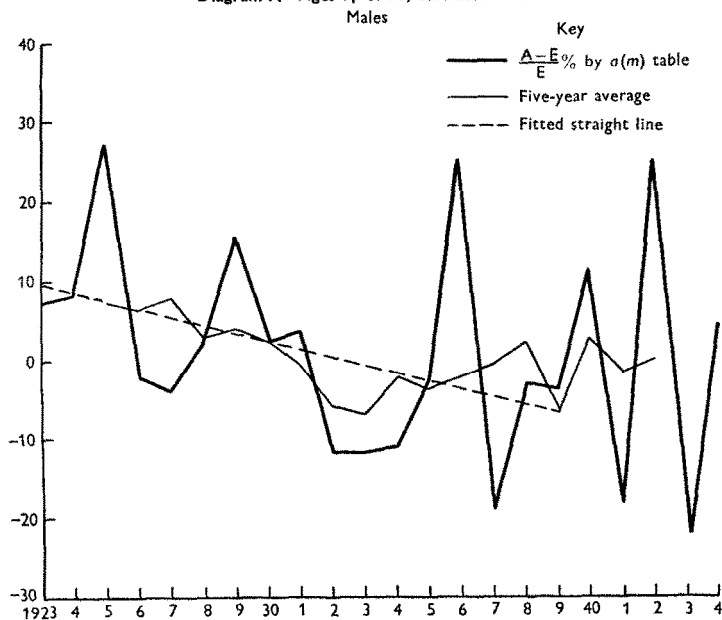
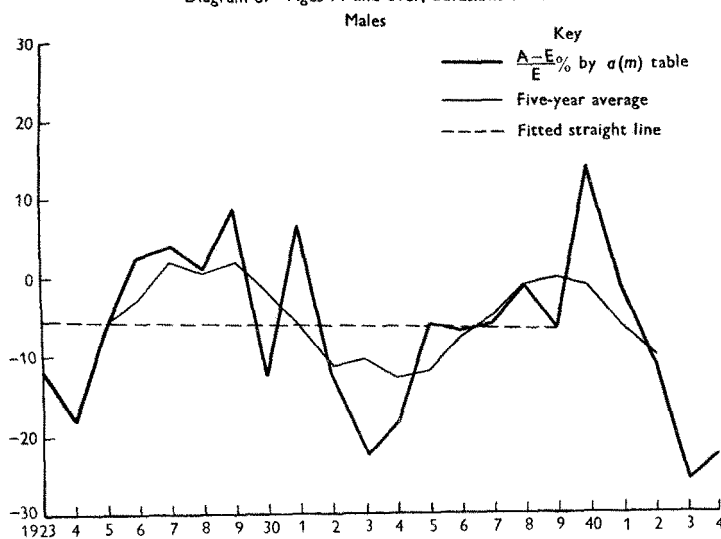


Diagram 8. Ages 71 and over, durations 0—4.



of the rates of mortality actually experienced at the appropriate ages and in the appropriate calendar years of experience by annuitants at durations 5 and over combined. It should be noted that this basis is not entirely satisfactory since it must to some extent reflect changes in class selection in the past.

It is not possible from the statistics of the continuous investigation to obtain data for separate calendar years of entry, but the experience at duration 0 in 1921, duration 1 in 1922, etc., may be traced as applicable to entrants in the years 1920-21. Similarly the experience at duration 0 in 1922, duration 1 in 1923, etc., may be treated as applicable to entrants in 1921-22, and so on.

Table 4 sets out, for entrants in 1920-21, 1921-22, up to 1938-39, the percentages of actual deaths to expected deaths calculated as described above for each duration 0 to 4. The figures are given also for groups of entry years 1920-25, 1925-30, 1930-35, and 1935-39, and for all years of entry 1920-39 combined. The tables relate to annuitants for all ages combined—a limitation that must be borne in mind.

A table in this form, if it could be available for more than the first five years of duration, might provide a means of examining class selection and testing the view that the particular year of entry has a major influence on mortality rates experienced by entrants in that year. If subsequent mortality depends on the year of entry, one would expect to find that the ratios for individual entry years in successive years of duration would tend to be consistently above or consistently below the average for the particular durations for all entry years combined. Unfortunately, the table covers only durations 0-4 and does not provide an adequate basis on which to form reliable conclusions. As far as it goes, however, the table lends some support to the view that year of entry has some influence on mortality, i.e. that class selection exists and has effect for at least five years.

14. Table 4 also throws some light on the duration of temporary initial selection, and an examination of the figures suggests that after the first two years this factor may have ceased to matter, but unfortunately no information is available for durations beyond duration 4. It might be instructive to pursue investigations into class selection and temporary initial selection on the foregoing lines to higher durations and it is hoped that it may be possible in future to obtain the necessary information from the offices. Meanwhile, it is considered desirable to publish the figures that are available in order that actuaries may have an opportunity to consider the implications and perhaps follow up some of the interesting speculations to which they may give rise.