JIA 87 (1961) 371-383

MORTALITY OF ASSURED LIVES IN SOUTH AFRICA

CONTINUOUS INVESTIGATION 1956–58

[The following is a slightly abbreviated version of a report by the Mortality Standing Committee of the Actuarial Society of South Africa, which has been made available by courtesy of that Society. The report was discussed at meetings of the Society in Johannesburg on 28 November 1960 and in Cape Town on 23 January 1961; abstracts of the discussions and a written reply thereto on behalf of the Committee have been placed in the Institute Library.—Eds. *J.I.A.*]

(1) *Origin and scope of investigation*

AT the 1956 Annual General Meeting of the Society it was decided to ask life offices to contribute appropriate data to a Continuous Mortality Investigation to be conducted under the auspices of the Society.

Data were called for in respect of ordinary life business; i.e. industrial and funeral business, annuity business, group assurance schemes and deferred annuity pension schemes were to be excluded. The subdivision of the data was basically as follows:

(i) Territory: Union, Central African Federation, East Africa.
(ii) Race: Europeans, Africans, Indians and Coloured lives.
(iii) Medical and Non-medical separately.

Cases not accepted at ordinary rates for the race concerned were to be excluded. Separate returns were to be made in respect of female lives unless the proportion of female lives was small. Offices were asked if possible to make returns both on a sum assured basis and on a number of policies basis. Selection was to be traced for three years.

(2) *Response to investigation*

The first returns received related to the census date falling in the year 1956. Eleven offices commenced contributing at that stage, one further office commenced in 1957, and one in 1958. The thirteen offices represent some 70 % of the industry, judged by premium income. It is hoped eventually to cover at least 90 % of the industry.

(3) *Selection of data for first investigation*

Table 1 sets out the totals of the available data in the various subsections.

It was decided to concentrate on the subsection with the largest amount of data, as this was most likely to produce reliable results.

Other portions of the experience will be investigated later as time permits, and as the volume of data becomes sufficiently large to produce reliable results.

The subsection of the data chosen for the first investigation was therefore in respect of Europeans in the Union. It was decided to produce a table of graduated ultimate (3 years' duration and over) rates of mortality, combining medical and non-medical business, and to use these rates of mortality as a standard table to compare the medical experience with the non-medical experience. Time did not permit of the investigation of the select portion of the data.

It should be noted that while the subsection is described as being in respect of Europeans, some offices found it impracticable entirely to exclude non-European lives. A small proportion of non-European lives is therefore included in the experience. The experience is also preponderantly in respect of male lives, the proportion of female lives being small.

All offices participating in the investigation made returns on a policies basis, whereas five offices did not make a sum-assured basis return, and one other office did so for only part of the period. The investigation was therefore made on a policies basis.

(4) *Period of investigation and volume of data*

Seven offices had made returns in respect of four census dates, i.e. 1956 to 1959 inclusive. Of the other six offices, five made three returns and one made two returns.

A decision had to be made on whether to adopt a period for the investigation such that all offices contributed for the same period. An analysis of the combined experience of all offices for the 1956, 1957 and 1958 census returns separately showed a sufficient degree of correspondence for the whole of the data to be adopted as the basis of the investigation. The experience therefore covers the census dates falling in the calendar years 1956, 1957 and 1958 together with the associated deaths.

The volume of the data may be judged from the following figures:

	Exposed to risk	Deaths
Medical	786,033·5	8,688
Non-medical	744,253·0	2,992
Total	1,530,286·5	11,680

The detailed figures are set out in Tables 2–4.

Table 1. *Totals of exposed to risk and deaths for various subsections of the experience*

	Durations 0–2 years		Durations 3 years and over	
	Exposed to risk	Deaths	Exposed to risk	Deaths
Europeans: Medical				
Union	162,915	425	786,034	8,688
Central African Federation	20,800	56	69,488	492
East Africa	8,062	11	18,304	123
Europeans: Non-medical				
Union	422,890	850	744,253	2,992
Central African Federation	45,526	84	52,012	168
East Africa	9,193	9	5,781	7
Coloureds	9,413	18	10,543	50
Natives	1,488	2	11,972	47
Indians	24,091	61	46,380	346

(5) *Graduation*

Ungraduated rates of mortality for half-ages were derived using the 'modified policy year' method of Haynes.* Ultimate rates of mortality for the policy year commencing in financial year N are given by

$q_{x-\frac{1}{2}}$ = [Deaths after policy anniversary in year N aged x nearest birthday at end of year N *plus* deaths before policy anniversary in year $(N+1)$ aged x nearest birthday at end of year N] ÷ [In force at end of year N aged x nearest birthday *plus* deaths after policy anniversary in year N aged x nearest birthday at end of year N].

The ungraduated rates of mortality (medical and non-medical combined) for durations 3 years and over, so arrived at, are set out in Table 4. The ungraduated values of $q_{x-\frac{1}{2}}$ for x from 17 to 96 inclusive were used to produce graduated values of $q_{x-\frac{1}{2}}$ for x from 27 to 86 inclusive, using the Spencer 21-term summation formula. The calculations were done on an electronic computer. The graduated values for x from 77 to 82 inclusive were adjusted by inspection to improve the run of the figures.

The usual tests of graduation were applied over the age range $26\frac{1}{2}$ to $85\frac{1}{2}$. The progression of the rates is not ideally smooth, but is certainly smooth enough for practical purposes. Expected deaths over the range are 11,264·8 as against actual deaths of 11,265. The individual deviations seldom exceed twice the standard error of the deviations. The successive deviations change sign frequently as do the accumulated deviations. The graduation was considered satisfactory and was adopted.

* *J.I.A.* 69, 154.

Table 2. *South African Assured Lives* 1956–58 (*durations* 3 *years and over*): *exposed to risk, deaths, and observed rates of mortality*

Europeans–Union–Medical

Nearest age x	Exposed to risk	Deaths	$q_{x-\frac{1}{2}}$	Nearest age x	Exposed to risk	Deaths	$q_{x-\frac{1}{2}}$
15	46·75	—	·00000	60	10834·5	212	·01957
16	82·75	—	·00000	61	9782·75	184	·01881
17	157·75	1	·00634	62	9007	232	·02576
18	482·75	2	·00414	63	8493·75	228	·02684
19	710·75	2	·00281	64	7969·5	180	·02259
20	1132·25	4	·00353	65	7220	187	·02590
21	2052·5	2	·00097	66	6734·5	222	·03296
22	3069·5	4	·00130	67	6300·25	264	·04190
23	4039·5	8	·00198	68	5875·5	231	·03932
24	5032	5	·00099	69	5482·5	251	·04578
25	6304·5	5	·00079	70	5010	199	·03972
26	7955·25	9	·00113	71	4357·25	190	·04361
27	9749·25	8	·00082	72	3874·75	217	·05600
28	11355·25	7	·00062	73	3656·5	190	·05196
29	12511·25	20	·00160	74	3507·75	192	·05474
30	13733·25	16	·00117	75	3341·5	210	·06285
31	14921·75	25	·00168	76	3050·5	266	·08720
32	16082·75	32	·00199	77	2676	229	·08558
33	16993·25	24	·00141	78	2345·75	192	·08185
34	17785·25	21	·00118	79	1941·5	185	·09529
35	19041·25	36	·00189	80	1640·5	155	·09448
36	20111	45	·00224	81	1394	168	·12052
37	20613·25	49	·00238	82	1145·75	131	·11434
38	20612	50	·00243	83	886·75	119	·13420
39	20712·25	53	·00256	84	656·5	74	·11272
40	21242·5	50	·00235	85	533·25	60	·11252
41	21844·25	81	·00371	86	409·75	71	·17328
42	22598·75	88	·00389	87	301·75	49	·16239
43	23573	73	·00310	88	211·5	31	·14657
44	24593·5	114	·00464	89	166	33	·19880
45	24741·5	94	·00380	90	122·5	12	·09796
46	24973	113	·00452	91	102	23	·22549
47	25097·75	147	·00586	92	55·5	13	·23423
48	25059·5	171	·00682	93	40	12	·30000
49	24986	177	·00708	94	19·5	3	·15385
50	24150·25	174	·00720	95	14·75	3	·20339
51	23718·5	186	·00784	96	14·5	6	·41379
52	23137	226	·00977	97	8	1	·12500
53	21579	205	·00950	98	6	—	·00000
54	19435	180	·00926	99	2	2	1·00000
55	16093·75	191	·01187	100	3	—	·00000
56	14348·25	194	·01352	and over			
57	14013·75	157	·01120		786,033·5	8,688	
58	13624·25	199	·01461				
59	12740·75	213	·01672				

Table 3. *South African Assured Lives* 1956–58 (*durations* 3 *years and over*): *exposed to risk, deaths, and observed rates of mortality*

Europeans–Union–Non-medical

Nearest age x	Exposed to risk	Deaths	$q_{x-\frac{1}{2}}$	Nearest age x	Exposed to risk	Deaths	$q_{x-\frac{1}{2}}$
15	162·5	—	·00000	60	2238·25	38	·01699
16	272·5	—	·00000	61	1963	46	·02343
17	470·25	—	·00000	62	1732·5	41	·02367
18	2000	5	·00250	63	1552·75	41	·02640
19	3052·75	5	·00164	64	1302·25	37	·02841
20	5182	10	·00193	65	1091·75	27	·02473
21	8766·25	18	·00205	66	929·25	30	·03228
22	12521	28	·00223	67	842·25	31	·03681
23	15077	21	·00139	68	701·25	42	·05989
24	17490·5	32	·00183	69	550	26	·04727
25	19958·25	32	·00160	70	425·25	26	·06114
26	22460·25	34	·00151	71	330·25	22	·06662
27	24524·5	27	·00110	72	279·75	12	·04290
28	25754·75	35	·00136	73	214·5	17	·07925
29	25972	30	·00116	74	147·5	14	·09492
30	25854·25	29	·00112	75	92	9	·09783
31	25647·25	39	·00152	76	75	8	·10667
32	25560·5	34	·00133	77	60·25	2	·03320
33	25420·5	46	·00181	78	39	5	·12821
34	25312·75	32	·00126	79	20·75	1	·04819
35	25526	48	·00188	80	9·5	4	·42105
36	25904·75	59	·00228	81	3	—	·00000
37	25485·5	69	·00271	82	1·75	—	·00000
38	24748·25	60	·00242	83	4·25	2	·47059
39	24006·5	51	·00212	84	3	1	·33333
40	23792·75	69	·00290	85	2	—	·00000
41	23158·25	58	·00250	86	1	—	·00000
42	22805·5	86	·00377	87	1	—	·00000
43	22745·5	86	·00378	88	—	—	—
44	22619·75	85	·00376	89	—	—	—
45	21335·25	104	·00487	90	—	—	—
46	20418·25	93	·00455	91	—	—	—
47	19676·25	109	·00554	92	—	—	—
48	18550·25	109	·00588	93	1	—	·00000
49	17063·75	136	·00797	94	—	—	—
50	15011·75	126	·00839	95	—	—	—
51	13469·75	114	·00846	96	—	—	—
52	12128·25	96	·00791	97	—	—	—
53	10422·75	92	·00883	98	—	—	—
54	8236·75	94	·01141	99	—	—	—
55	5814·75	75	·01290	100	1	—	·00000
56	4689·5	66	·01407	and over			
57	4034·75	59	·01462		744,253·0	2,992	
58	3494·25	59	·01688				
59	3039·25	50	·01645				

Table 4. *South African Assured Lives* 1956–58 (*durations 3 years and over*): *exposed to risk, deaths, and observed rates of mortality*

Europeans–Union–Medical and non-medical combined

Nearest age x	Exposed to risk	Deaths	$q_{x-\frac{1}{2}}$	Nearest age x	Exposed to risk	Deaths	$q_{x-\frac{1}{2}}$
15	209·25	—	·00000	60	13072·75	250	·01912
16	355·25	—	·00000	61	11745·75	230	·01958
17	628	1	·00159	62	10739·5	273	·02542
18	2482·75	7	·00282	63	10046·5	269	·02678
19	3763·5	7	·00186	64	9271·75	217	·02340
20	6314·25	14	·00222	65	8311·75	214	·02575
21	10818·75	20	·00185	66	7663·75	252	·03288
22	15590·5	32	·00205	67	7142·5	295	·04130
23	19116·5	29	·00152	68	6576·75	273	·04151
24	22522·5	37	·00164	69	6032·5	277	·04592
25	26262·75	37	·00141	70	5435·25	225	·04140
26	30415·5	43	·00141	71	4687·5	212	·04523
27	34273·75	35	·00102	72	4154·5	229	·05512
28	37110	42	·00113	73	3871	207	·05347
29	38483·25	50	·00130	74	3655·25	206	·05636
30	39587·5	45	·00114	75	3433·5	219	·06378
31	40569	64	·00158	76	3125·5	274	·08767
32	41643·25	66	·00158	77	2736·25	231	·08442
33	42413·75	70	·00165	78	2384·75	197	·08261
34	43098	53	·00123	79	1962·25	186	·09479
35	44567·25	84	·00188	80	1650	159	·09636
36	46015·75	104	·00226	81	1397	168	·12026
37	46098·75	118	·00256	82	1147·5	131	·11416
38	45360·25	110	·00243	83	891	121	·13580
39	44718·75	104	·00233	84	659·5	75	·11372
40	45035·25	119	·00264	85	535·25	60	·11210
41	45002·5	139	·00309	86	410·75	71	·17285
42	45404·25	174	·00383	87	302·75	49	·16185
43	46318·5	159	·00343	88	211·5	31	·14657
44	47213·25	199	·00421	89	166	33	·19880
45	46076·75	198	·00430	90	122·5	12	·09796
46	45391·25	206	·00454	91	102	23	·22549
47	44774	256	·00572	92	55·5	13	·23423
48	43609·75	280	·00642	93	41	12	·29268
49	42049·75	313	·00744	94	19·5	3	·15385
50	39162	300	·00766	95	14·75	3	·20339
51	37188·25	300	·00807	96	14·5	6	·41379
52	35265·25	322	·00913	97	8	1	·12500
53	32001·75	297	·00928	98	6	—	·00000
54	27671·75	274	·00990	99	2	2	1·00000
55	21908·5	266	·01214	100	4	—	·00000
56	19037·75	260	·01366	and over			
57	18048·5	216	·01197		1,530,286·5	11,680	
58	17118·5	258	·01507				
59	15780	263	·01667				

The remaining graduation problems concerned the completion of the two ends of the curve. At the young ages the data show a 'hump' in the curve round about ages 18–22, presumably due to accidental deaths. There is a corresponding 'hollow' about age 28. It was decided to complete this portion of the curve by graphic graduation, and to preserve the features shown by the crude rates of mortality. The usual tests of graduation were applied, and showed the graphic graduation to be satisfactory.

Table 5. *South African Assured Lives* 1956–58 (*durations* 3 *years and over*): *graduated rates of mortality and comparison of actual deaths with expected deaths computed from graduated rates of mortality*

European–Union–Medical and non-medical combined

Nearest age x	Graduated $q_{x-\frac{1}{2}}$	Actual deaths	Expected deaths	Actual – Expected deaths +	Actual – Expected deaths –	Accumulated deviation +	Accumulated deviation –	Standard error
15	·00140	—	·3	—	·3	—	·3	·5
16	·00162	—	·6	—	·6	—	·9	·8
17	·00192	1	1·2	—	·2	—	1·1	1·1
18	·00207	7	5·1	1·9	—	·8	—	2·3
19	·00210	7	7·9	—	·9	—	·1	2·8
20	·00206	14	13·0	1·0	—	·9	—	3·6
21	·00198	20	21·4	—	1·4	—	·5	4·6
22	·00186	32	29·0	3·0	—	2·5	—	5·4
23	·00173	29	33·1	—	4·1	—	1·6	5·8
24	·00160	37	36·0	1·0	—	—	·6	6·0
25	·00146	37	38·3	—	1·3	—	1·9	6·2
26	·00135	43	41·1	1·9	—	—	—	6·4
27	·00126	35	43·2	—	8·2	—	8·2	6·6
28	·00123	42	45·6	—	3·6	—	11·8	6·8
29	·00123	50	47·3	2·7	—	—	9·1	6·9
30	·00128	45	50·7	—	5·7	—	14·8	7·1
31	·00135	64	54·8	9·2	—	—	5·6	7·4
32	·00146	66	60·8	5·2	—	—	·4	7·8
33	·00158	70	67·0	3·0	—	2·6	—	8·2
34	·00172	53	74·1	—	21·1	—	18·5	8·6
35	·00188	84	83·8	·2	—	—	18·3	9·2
36	·00204	104	93·9	10·1	—	—	8·2	9·7
37	·00222	118	102·3	15·7	—	7·5	—	10·1
38	·00241	110	109·3	·7	—	8·2	—	10·5
39	·00261	104	116·7	—	12·7	—	4·5	10·8
40	·00282	119	127·0	—	8·0	—	12·5	11·3
41	·00306	139	137·7	1·3	—	—	11·2	11·7
42	·00334	174	151·7	22·3	—	11·1	—	12·3
43	·00367	159	170·0	—	11·0	·1	—	13·0
44	·00407	199	192·2	6·8	—	6·9	—	13·9
45	·00454	198	209·2	—	11·2	—	4·3	14·5
46	·00506	206	229·7	—	23·7	—	28·0	15·2
47	·00564	256	252·5	3·5	—	—	24·5	15·9
48	·00625	280	272·6	7·4	—	—	17·1	16·5
49	·00689	313	289·7	23·3	—	6·2	—	17·0

Table 5 (*cont.*)

Nearest age x	Graduated $q_{x-\frac{1}{2}}$	Actual deaths	Expected deaths	Actual – Expected deaths +	Actual – Expected deaths –	Accumulated deviation +	Accumulated deviation –	Standard error
50	·00754	300	295·3	4·7	—	10·9	—	17·2
51	·00822	300	305·7	—	5·7	5·2	—	17·5
52	·00891	322	314·2	7·8	—	13·0	—	17·7
53	·00963	297	308·2	—	11·2	1·8	—	17·6
54	·01044	274	288·9	—	14·9	—	13·1	17·0
55	·01139	266	249·5	16·5	—	3·4	—	15·8
56	·01251	260	238·2	21·8	—	25·2	—	15·4
57	·01382	216	249·4	—	33·4	—	8·2	15·8
58	·01527	258	261·4	—	3·4	—	11·6	16·2
59	·01684	263	265·7	—	2·7	—	14·3	16·3
60	·01853	250	242·2	7·8	—	—	6·5	15·5
61	·02040	230	239·6	—	9·6	—	16·1	15·4
62	·02247	273	241·3	31·7	—	15·6	—	15·5
63	·02481	269	249·3	19·7	—	35·3	—	15·8
64	·02745	217	254·5	—	37·5	—	2·2	16·0
65	·03033	214	252·1	—	38·1	—	40·3	15·9
66	·03329	252	255·1	—	3·1	—	43·4	16·0
67	·03621	295	258·6	36·4	—	—	7·0	16·1
68	·03907	273	257·0	16·0	—	9·0	—	16·0
69	·04192	277	252·9	24·1	—	33·1	—	15·9
70	·04490	225	244·0	—	19·0	14·1	—	15·6
71	·04819	212	225·9	—	13·9	·2	—	15·0
72	·05204	229	216·2	12·8	—	13·0	—	14·7
73	·05661	207	219·1	—	12·1	·9	—	14·8
74	·06197	206	226·5	—	20·5	—	19·6	15·0
75	·06810	219	233·8	—	14·8	—	34·4	15·3
76	·07483	274	233·9	40·1	—	5·7	—	15·3
77	·08191	231	224·1	6·9	—	12·6	—	15·0
78	·08904	197	212·3	—	15·3	—	2·7	14·6
79	·09592	186	188·2	—	2·2	—	4·9	13·7
80	·10263	159	169·3	—	10·3	—	15·2	13·0
81	·10920	168	152·6	15·4	—	·2	—	12·4
82	·11572	131	132·8	—	1·8	—	1·6	11·5
83	·12222	121	108·9	12·1	—	10·5	—	10·4
84	·12882	75	85·0	—	10·0	·5	—	9·2
85	·13560	60	72·6	—	12·6	—	12·1	8·5
86	·14288	71	58·7	12·3	—	·2	—	7·7
87	·15102	49	45·7	3·3	—	3·5	—	6·8
88	·16004	31	33·8	—	2·8	·7	—	5·8
89	·16994	33	28·2	4·8	—	5·5	—	5·3
90	·18072	12	22·1	—	10·1	—	4·6	4·7
91	·19238	23	19·6	3·4	—	—	1·2	4·4
92	·20492	13	11·4	1·6	—	·4	—	3·4
93	·21834	12	9·0	3·0	—	3·4	—	3·0
94	·23264	3	4·5	—	1·5	1·9	—	2·1
95	·24782	3	3·7	—	·7	1·2	—	1·9
96	·26388	6	3·8	2·2	—	3·4	—	1·9
97	·28082	1	2·2	—	1·2	2·2	—	1·5
98	·29864	—	1·8	—	1·8	·4	—	1·3
99	·31734	2	·6	1·4	—	1·8	—	·8
100	·33692	—	·3	—	·3	1·5	—	·5
101	·35738	—	·7	—	·7	·8	—	·8
102	·37872	—	·4	—	·4	·4	—	·6
		11,680	11,679·6	426·0	425·6	—	—	887·6

At the high ages an attempt at a graphic graduation showed that a second degree polynomial would be appropriate. The formula

$$q_{85\frac{1}{2}+h} = q_{85\frac{1}{2}} + \cdot 0077h + \cdot 00044h^2$$

was adopted after it had been established that it would fit the data satisfactorily.

Table 5 shows the graduated rates of mortality for ages $14\frac{1}{2}$ to $101\frac{1}{2}$, together with the actual and expected deaths, deviations, accumulated deviations and the standard errors of the deviations. The standard error has been taken as the square root of the expected deaths.

(6) *Comparison with standard tables*

For the purposes of identification the mortality table arrived at in this investigation is designated the S.A. 56/58 Ultimate Table.

The following table compares ultimate rates of mortality from the S.A. 56/58 Ultimate Table with those from various standard tables. The figures in parentheses are the S.A. 56/58 rates of mortality as a percentage of the standard table rates of mortality.

q_x *Ultimate*

Age	S.A. 56/58	A 1924–29	A 1924–29 Light	A 1949–52	C.S.O. 58 Basic
15	·00150	·00206 (73)	·00164 (91)	·00111 (135)	·00056 (268)
20	·00203	·00235 (86)	·00172 (118)	·00111 (183)	·00084 (242)
25	·00140	·00235 (60)	·00190 (74)	·00112 (125)	·00093 (151)
30	·00131	·00241 (54)	·00207 (63)	·00116 (113)	·00108 (121)
35	·00196	·00286 (69)	·00231 (85)	·00132 (148)	·00141 (139)
40	·00294	·00388 (76)	·00310 (95)	·00188 (156)	·00236 (125)
45	·00479	·00527 (91)	·00426 (112)	·00330 (145)	·00403 (119)
50	·00788	·00764 (103)	·00635 (124)	·00599 (132)	·00671 (117)
55	·01193	·01190 (100)	·00983 (121)	·01035 (115)	·01093 (109)
60	·01944	·01973 (99)	·01574 (124)	01720 (113)	·01756 (111)
65	·03182	·03188 (100)	·02662 (120)	·02810 (113)	·02761 (115)
70	·04648	·05327 (87)	·04666 (100)	·04543 (102)	·04330 (107)
75	·07142	·08497 (84)	·07856 (91)	·07257 (98)	·06380 (112)
80	·10592	·12910 (82)	·12019 (88)	·11369 (93)	·09564 (111)
85	·13913	·18676 (74)	·17254 (81)	·17282 (81)	·14012 (99)
90	·18644	·25611 (73)	·24164 (77)	·25168 (74)	·19838 (94)

N.B. The C.S.O. 58 Basic Table is a recent American table that is stated to represent the average company ultimate mortality on standard ordinary business for the period 1950 to 1954.

In considering the results of the experience an assessment needs to be made of the degree of reliance that can be placed on the results. The A 1924–29 and A 1949–52 investigations each had about seven times the volume of data of the S.A. 56/58 investigation. On the other hand, an exposed to risk of some $1\frac{1}{2}$ million policy years is a very considerable

Table 6. *S.A.* 56/58 *Ultimate Table* (*durations* 3 *years and over*)

Europeans–Union–Medical and non-medical combined

x	q_x	l_x	e_x	x	q_x	l_x	e_x
15	·00150	9,999,999	55·403	60	·01944	8,084,393	16·050
16	·00179	9,984,999	54·486	61	·02140	7,927,232	15·368
17	·00201	9,967,126	53·584	62	·02360	7,757,590	14·705
18	·00209	9,947,092	52·692	63	·02610	7,574,511	14·060
19	·00209	9,926,303	51·802	64	·02888	7,376,816	13·437
20	·00203	9,905,557	50·911	65	·03182	7,163,773	12·836
21	·00192	9,885,448	50·014	66	·03476	6,935,822	12·258
22	·00180	9,866,468	49·111	67	·03764	6,694,733	11·700
23	·00167	9,848,709	48·199	68	·04048	6,442,743	11·157
24	·00153	9,832,261	47.280	69	·04337	6,181,941	10·628
25	·00140	9,817,218	46·352	70	·04648	5,913,830	10·110
26	·00130	9,803,474	45·417	71	·05003	5,638,955	9·603
27	·00124	9,790,729	44·476	72	·05423	5,356,838	9·108
28	·00122	9,778,589	43·532	73	·05919	5,066,337	8·631
29	·00125	9,766,659	42·585	74	·06496	4,766,461	8·174
30	·00131	9,754,451	41·638	75	·07142	4,456,831	7·741
31	·00140	9,741,672	40·693	76	·07836	4,138,524	7·337
32	·00152	9,728,034	39·750	77	·08551	3,814,230	6·961
33	·00165	9,713,247	38·810	78	·09250	3,488,075	6·612
34	·00180	9,697,220	37·874	79	·09929	3,165,428	6·285
35	·00196	9,679,765	36·943	80	·10592	2,851,133	5·978
36	·00213	9,660,793	36·015	81	·11246	2,549,141	5·687
37	·00231	9,640,216	35·092	82	·11896	2,262,464	5·407
38	·00251	9,617,947	34·173	83	·12550	1,993,322	5·137
39	·00271	9,593,806	33·259	84	·13215	1,743,160	4·874
40	·00294	9,567,806	32·350	85	·13913	1,512,801	4·617
41	·00319	9,539,677	31·445	86	·14684	1,302,325	4·363
42	·00350	9,509,245	30·546	87	·15542	1,111,092	4·114
43	·00386	9,475,963	29·653	88	·16488	938,406	3·871
44	·00430	9,439,386	28·768	89	·17522	783,681	3·635
45	·00479	9,398,797	27·892	90	·18644	646,365	3·407
46	·00535	9,353,776	27·026	91	·19854	525,857	3·188
47	·00594	9,303,734	26·172	92	·21152	421,453	2·977
48	·00657	9,248,469	25·328	93	·22538	332,307	2·776
49	·00721	9,187,707	24·496	94	·24012	257,412	2·584
50	·00788	9,121,464	23·674	95	·25574	195,602	2·400
51	·00856	9,049,586	22·862	96	·27224	145,579	2·225
52	·00926	8,972,122	22·059	97	·28962	105,946	2·058
53	·01002	8,889,040	21·265	98	·30788	75,262	1·896
54	·01089	8,799,972	20·480	99	·32702	52,090	1·740
55	·01193	8,704,140	19·706	100	·34704	35,056	1·586
56	·01315	8,600,300	18·944	101	·36794	22,890	1·428
57	·01453	8,487,206	18·196	102	·38972	14,468	1·260
58	·01604	8,363,887	17·464	103	·40000	8,830	1·064
59	·01766	8,229,730	16·749	104	·50000	5,298	·773

amount of data, and bearing in mind that the general level of mortality for the three years taken separately was very similar, it is felt that the table produced gives a good measure of current ultimate assured lives mortality for European male lives in the Union.

The general shape of the mortality curve for the Union is different from the four standard tables with which a comparison is made, although there is a marked similarity (but a different level) over certain wide ranges of ages. For example, compare the mortality rates at ages 50–69 with A 1924–29 Light, or at ages 50–84 with C.S.O. 58.

As regards the level of mortality, the S.A. table is generally lower than A 1924–29, lower than A 1924–29 Light except at the important middle ages, lower than A 1949–52 only from the mid-70's, and lower than C.S.O. 58 only at the very high ages.

At the younger ages the S.A. table is perhaps surprisingly in excess of the modern British and American experience. It is estimated that accidental deaths account for more than 40 % of the total deaths below age 40 amongst European assured lives in the Union. Comparable figures for Britain and America would establish whether or not the Union's high accident rate is the main reason for the relatively less favourable mortality at the younger ages.

It has been said that the Union is second only to the U.S.A. in the incidence of coronary heart disease amongst males. The high incidence of deaths from this type of disease in the Union may well explain the relationship between the S.A. table and A 1949–52 from the middle ages up to the mid-70's, but if the U.S.A. has a still higher incidence than the Union, the relatively lower American experience at these ages is somewhat puzzling.

At the high ages the S.A. 56/58 experience is good. The question arises whether this is genuine or whether the inclusion of numbers of small paid-up policies where the assured lives have died, but where the policies remain on the books because the deaths have not been notified, has artificially lowered the experience rates of mortality. To guard against this possibility offices were asked to exclude all policies where the sum assured was less than £100, and this was done in respect of at least 60 % of the experience. The light experience is therefore more likely to be genuine than not, and on general grounds there are two reasons for expecting light mortality at high ages in the Union. First, the climate is more favourable to survival at the older ages than is the case in say Britain. Secondly, the heavier death-rates at the earlier ages can lead to a relative improvement at the older ages on the principle of 'the survival of the fittest'.

(7) *Medical and non-medical experience*

The following table sets out a comparison of the medical and non-medical sections of the experience. The expected deaths have been calculated using the graduated values of $q_{x-\frac{1}{2}}$ derived from the combined experience.

Age-group	Medical			Non-medical			
	A	E	$\frac{100\,A}{E}$	A	E	$\frac{100\,A}{E}$	$\frac{\text{Medical}}{\text{Non-medical}}$ %
15–19	5	3·0	166·7	10	12·0	83·3	200·1
20–24	23	27·2	84·6	109	105·5	103·3	81·9
25–29	49	61·6	79·5	158	153·9	102·7	77·4
30–34	118	118·6	99·5	180	188·7	95·4	104·3
35–39	233	226·4	102·9	287	279·7	102·6	100·3
40–44	406	388·8	104·4	384	389·8	98·5	106·0
45–49	702	709·1	99·0	551	544·7	101·2	97·8
50–54	971	994·0	97·7	522	518·4	100·7	97·0
55–59	954	979·1	97·4	309	285·3	108·3	89·9
60–64	1036	1032·3	100·4	203	194·6	104·3	96·3
65–69	1155	1130·7	102·1	156	145·0	107·6	94·9
70–74	988	1060·9	93·1	91	70·8	128·5	72·5
75–79	1082	1070·2	101·1	25	22·3	112·1	90·2
80–84	647	646·2	100·1	7	2·4	291·7	34·3
85–89	244	238·4	102·3	—	·6	—	—
90–94	63	66·3	95·0	—	·2	—	—
95–99	12	12·1	99·2	—	—	—	—
100 and over	—	1·1	—	—	·4	—	—
Total	8688	8766·0	99·1	2992	2914·3	102·7	96·5

The correspondence between medical and non-medical mortality is somewhat closer than was the case with the A1949–52 experience (durations 3 years and over), where medical mortality was about 94% of non-medical mortality.

The Committee responsible for the A1949–52 investigation pointed out that the aggregate difference between medical and non-medical mortality was largely fortuitous, as the following quotation from their report shows:

> When comparisons are made between the medical and non-medical business of individual offices the margin between the mortality experienced by these two classes of business greatly diminishes. It seems, in fact, that a high proportion of the total non-medical business is transacted by offices whose mortality experience is heavier than average in all classes. Consequently, one reason why the non-medical experience is heavier than the medical experience is that it contains a higher proportion of data from 'heavy' offices.

In the present investigation comparisons of figures for individual offices have not been made, but it is likely that the same feature is present. Also, the fact that there are fewer contributing offices, and that

one office contributed about 60% of the data, may be the main reason for the closer correspondence of medical with non-medical mortality as compared with the A1949–52 investigation.

The figures in the table given above convey the impression that there is a different relationship between medical and non-medical mortality at the middle and higher ages as compared with the younger ages. Care is needed, however, in interpreting the figures, for somewhat different patterns are revealed by different groupings of the data, as follows:

Age-group	Medical / Non-medical %	Age-group	Medical / Non-medical %	Age-group	Medical / Non-medical %
15–24	91·5	15–29	82·2	15–34	93·4
25–39	98·0	30–44	104·0	35–49	100·7
40–54	99·1	45–59	95·5	50–64	95·1
55–69	93·6	60–74	90·0	65–79	86·6
70–	77·1	75–	81·5	80–	51·5

(8) *Conclusion*

The mortality table produced by the investigation can be regarded as a useful measure of European male assured life mortality in the Union. It does not purport to represent the experience of any one office, nor of any one class of business, and actuaries will no doubt wish to compare their own offices' experience with the average experience as represented by the table.

Much remains to be done, for no attempt has yet been made to investigate select rates of mortality, nor non-Union mortality, nor the mortality of non-European lives. All of these investigations will be pursued, and the main investigation will be added to as more data become available.

As stated earlier, relatively few returns were made on a sum-assured basis. For the Committee to make use of the data it will have to make a comparison, for each office that makes a sum-assured return, between the policies basis returns and the sum-assured basis returns, or to make a similar comparison for the total of the data for these offices. As some offices prefer not to have their individual results available to anyone other than themselves, the Committee is averse to making comparisons for individual offices. Even the making of the combined comparison might well give an indication of the experience of an individual office. For this reason, and also because of the additional work entailed when so many other aspects still require to be investigated, the Committee would prefer not to pursue any investigation on a sum-assured basis. It is felt that returns should no longer be made to the Committee on a sum-assured basis, and that those offices that wish to see the effect of adopting this alternative unit of investigation should make their own comparisons from their own data.