DIABETES MORTALITY IN 1861–1942 AND SOME OF THE FACTORS AFFECTING IT

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(With 4 Figures in the Text)

In the records of the Registrar-General of England and Wales prior to the year 1940, diabetes was accorded by the rules of classification a high preference over other causes mentioned in association with it upon death certificates, the only important causes preferred to it being the infective diseases cancer, rheumatic fever, sequelae of syphilis, injuries, poisoning, acute intestinal obstruction and puerperal sepsis. It was ascertained from a sample of 123,000 deaths during 1921–30 that 91 % of all death certificates with mention of diabetes were classified to diabetes; in other words the death-rates represented 91 % of the total mortality suffered by persons recognized as diabetics and recorded on certificates as such. It is important to keep this fact in mind when seeking explanations for the trends of mortality at different ages between the years 1860 and 1940. The chief factors which influenced these trends are believed to have been:

(*a*) Increasing tendency to mention contributory causes on death certificates.

(*b*) Increasing use of urine analysis and detection thereby of slighter degrees of diabetes.

(*c*) Increasing consumption of sugar per head of the population.

(*d*) Food rationing during 1915–19.

(*e*) Introduction of insulin treatment about 1922–3.

The changes in the death-rates of each sex between 1861 and 1933 at four age periods 0–44, 45–54, 55–64 and 65 upwards were depicted in Diagram 4 at p. 82 of the *Registrar-General's Statistical Review* for 1933 (Text). In Figs. 1 and 2 and Table (*a*) of this paper the analysis has been made in greater detail of age, using seven groups, and has been extended to 1941. The vertical scale of death-rates per million living for age groups 55–64, 65–74 and 75 upwards is one-tenth of that used for the age groups 0–24 (standardized), 25–34, 35–44 and 45–54. The 1940–1 rates are corrected to the old method of classification so that they may be comparable with other years; they are not civilian rates but are based upon the mid-1939 population. The graphs show that:

(1) Death-rates increased continuously from 1861–70 to 1891–1900 at every age period in both sexes, except amongst males aged 25–34 who registered a slight fall in death-rate in 1891–1900.

(2) This increase continued until 1911–20 at ages under 35 and over 65 for males and at ages under 25 and 55 upwards for females, but the rise was arrested in 1901–10 for males aged 35–54 and about 1911–20 for males aged 55–64 and females aged 25–54.

(3) The period 1921–5, during which insulin was introduced, witnessed a considerable decline at every age group under 75 for males and under 55 for females.

(4) This decline continued up to 1936–9 at every age group under 45 for males and females; the rates remained constant at 45–64 for males and 45–54 for females and ceased to rise about 1933 for females aged 55–64; at ages over 65 for both sexes the increase in death-rates has continued as in the pre-insulin period, or even more rapidly at 75 and over.

(5) In 1940–1 the progressive improvement of male rates at ages under 25 and 35–44 and of female rates under 35 was interrupted, but on the other hand males aged 45–54 and females of 45 and over showed some improvement in mortality compared with 1936–9.

It is evident from (2) that the progressive rise in death-rates of the last century came to an end amongst males aged 35–54 before the sugar shortage of 1915–19, and the graphs from 1911 to 1941 in Fig. 3 and the rates in Table (*c*), which are founded upon rates for separate years, indicate that the temporary arrest in the increase amongst males of 55 and over also began in 1913, though it turned into a large decline in 1917. Amongst females of both age periods and amongst the younger males the decline began about 1915 and the arrest in the rise, or actual fall, noticed in Figs. 1 and 2 in 1911–20 was probably due to the rationing of sugar and other foods in the second half of that period. The effects of rationing on diabetes rates in the present war began to appear in 1941. The sharp fall in the female rate at 55 and over in Fig. 3 shows this, though the fall in the other rates might be accounted for by a reaction after the temporary increase in 1940 (attributable to the severe climatic and other conditions of that year). A temporary fall in all four rates occurred in 1936, which was difficult of explanation, but the decline in total deaths which commenced in 1941 continued unabated during 1942 and the first quarter of 1943, as will be shown at the end of this paper.

From (3) and (4) it is clear that insulin at once affected all death-rates except at advanced ages; and that it continued to bring down the rates or keep them steady, or eventually arrested their rise, at all ages up to 65; but at higher ages the effect was no more than temporary and at ages 75 and over the rates have risen during the insulin period even more quickly than before. This last effect might be expected, for insulin does not cure and the rates here dealt with measure mortality of diabetics from almost any cause. In the *Statistical Review* for 1933 (Text, p. 84) it was estimated that

insulin was probably prolonging the life of diabetics by about 8 years on the average.

Table (b) and Fig. 4 show that a progressive change has been taking place in the sex-ratio of mortality as far back as the records go, but although there was at ages under 55 a temporary arrest of this change in 1911–20, the graphs give no indication whatever of any effect on the sex-ratio of the introduction of insulin. In 1861–70 the male standardized rate at ages under 55 was nearly double that of females, but the ratio fell steadily to 119 % in 1901–10, remained about the same in 1911–20, and then continued to fall as before to 86 % in 1931–5 and 83 % in 1936–9. At ages 55 and over the standardized male rate was 2½ times that of females in 1861–70 and declined steadily to 77 % in 1931–5 and the same value in 1936–9. In 1940 and 1941 the ratio increased slightly at both age periods.

The Registrar-General for Scotland, Mr J. G. Kyd, who called attention in his report for 1940 to a progressive change in the sex-ratio of diabetes deaths in that country, has kindly furnished me with the following crude death-rates per million in periods around the last four census years and in 1938–40:

	1899–1903	1909–13	1919–23	1929–33	1938–40
Males:					
Under 35	34	40	37	19	16
35–54	98	109	87	70	72
55 and over	273	441	358	440	533
All ages	70	98	89	96	115
Females:					
Under 35	27	30	31	22	15
35–54	81	101	86	106	90
55 and over	258	473	500	778	1049
All ages	66	102	110	170	226
Male rate at all ages % of female	106	98	81	56	51

The England and Wales ratios derived from crude death-rates in 1901, 1911, 1921, 1931 and 1939, corresponding with the Scottish ratios, were 119, 108, 95, 69 and 66 respectively, the progression being similar although the ratios were higher throughout.

The sex-ratio for diabetes mortality has undergone a similar change in the United States of America, as shown by the crude death-rates per million population since 1900:

	1900	1910	1920	1930	1940
Males	112	140	144	150	200
Females	107	166	180	232	332
Male rate % of female	105	84	80	65	60

In Holland a similar trend in the sex-ratio is evident in the rates from 1920 to 1937:

	1920	1925	1930	1935	1937
Males	107	102	121	105	119
Females	146	188	231	243	262
Male rate % of female	73	54	52	43	45

In Sweden the percentage ratio of male to female deaths was 109 in 1911–15, 107 in 1916–20, 93 in 1921–5, 77 in
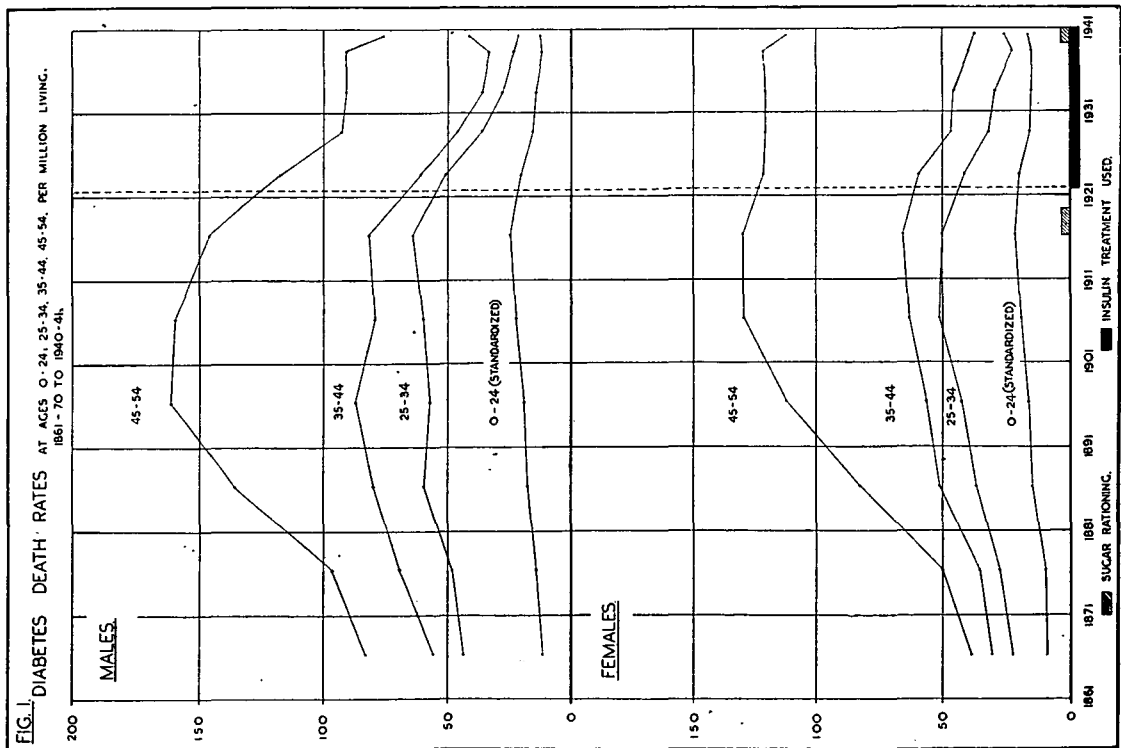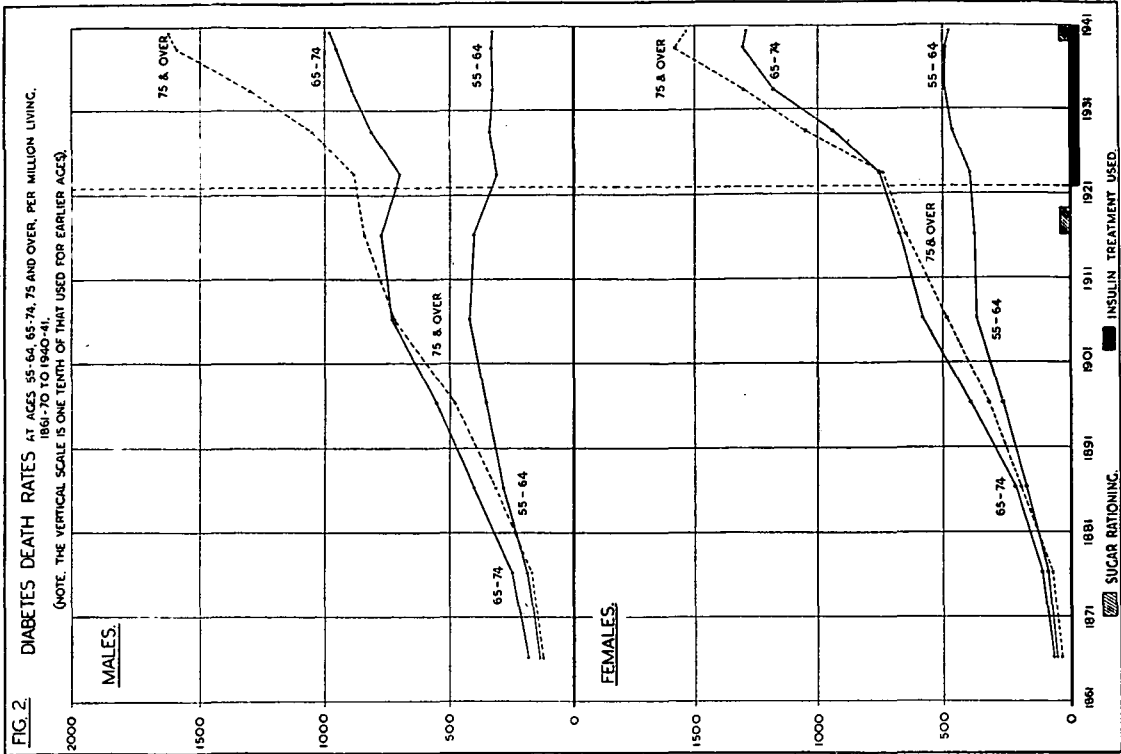
1926–30 and 66 in 1931–5. In New Zealand the male standardized death-rate in 1931–3 was 65 % of that of females; in 1934–6 it was 54 % and in 1937–9 55 %.

To what extent the upward trends of all rates in the last century, and of rates at ages 65 and over since the introduction of insulin, have been due to increasing diagnosis and mention on death certificates of diabetes is difficult to determine. Owing to the gradual extension of medical examinations for life insurance and other purposes the detection of diabetes must have been always more complete at earlier than late ages and must have extended gradually up the age scale. Whatever position has been reached in this respect at ages under 65 it is fairly certain that the amount of such detection in late life is still increasing and was up to 1939 contributing to the continued steep rise of death-rates at ages after 65. The change in method of classification of deaths in England and Wales since 1940, and consequent dual classification by the old and new methods during 1936–9, throws some light upon this, for the new system assigns to diabetes only those deaths where the certifier regarded diabetes as the principal cause leading up to the fatal issue and excludes those for which it was regarded as only a contributory cause. The *Registrar-General's Statistical Review* for 1939 gives the classification by sex and age by both methods (Table 21 and Appendix B 1), and shows that in that year the ratios of deaths classified according to the old method to the deaths attributed to diabetes by the certifier were as follows:
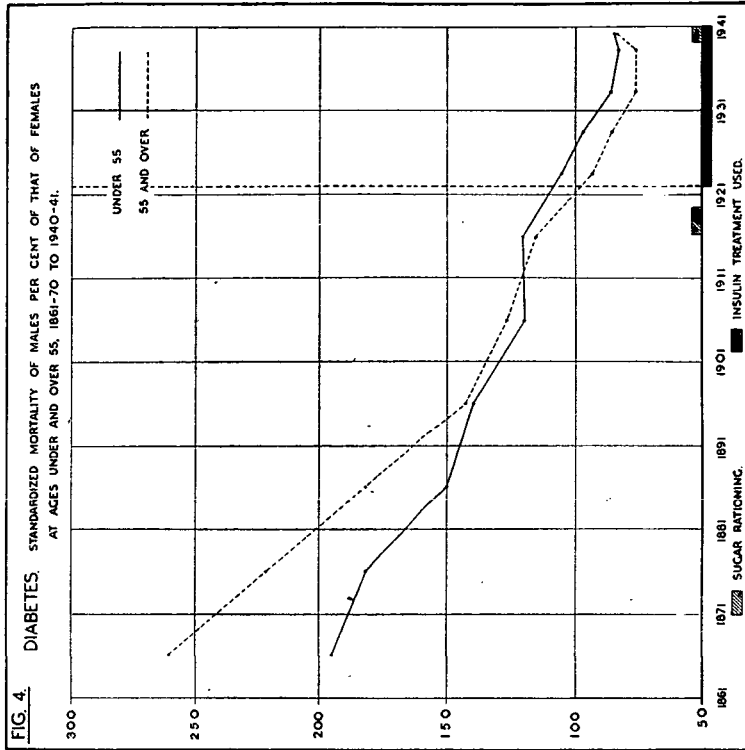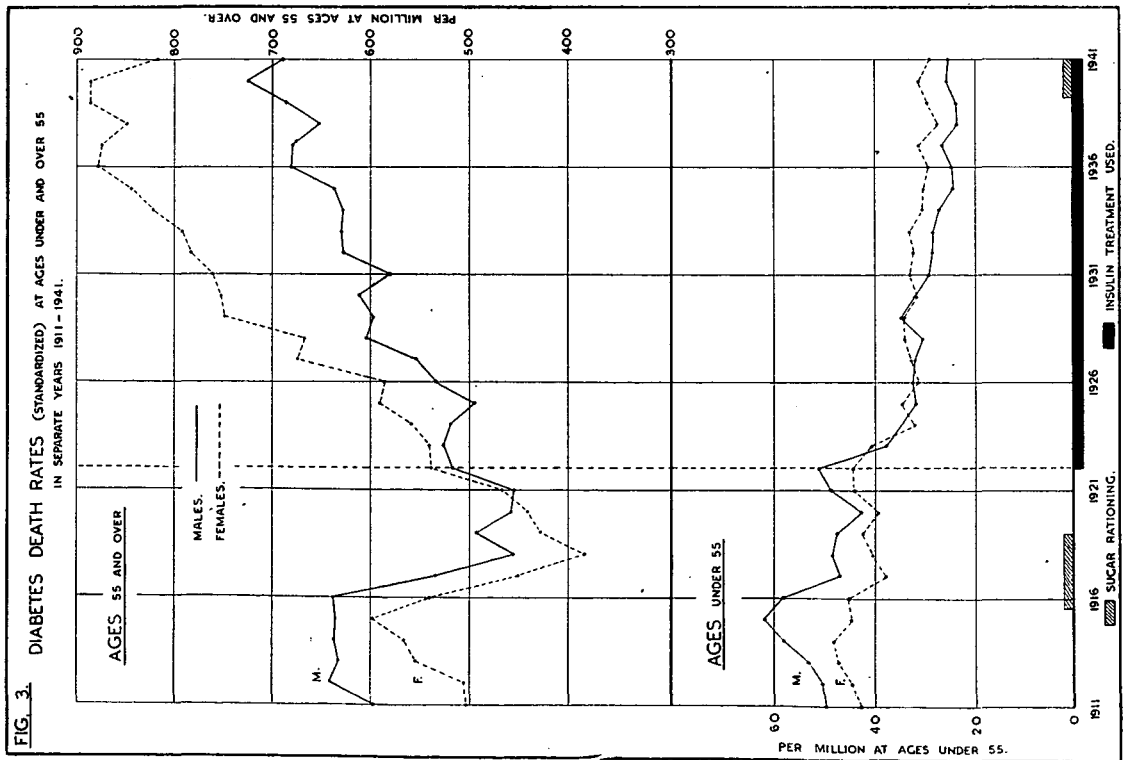
Ages ...	0–	15–	25–	35–	45–
Males	1·03	0·90	1·08	1·19	1·33
Females	1·02	1·05	1·18	1·11	1·22
Ages ...	55–	65–	75 up	All ages	
Males	1·63	1·60	1·65	1·53	
Females	1·42	1·56	1·52	1·45	

The ratio of 1·48 for all deaths means that out of 7627 deaths assigned to diabetes by the rules of precedence only two-thirds were considered by the certifier to be due to diabetes. Remembering that the death certificates with mention of diabetes were (in 1921–30) 10 % in excess of those classed to diabetes, it follows that not more than about 60 % of deaths of diabetics are considered to have been caused by diabetes. It is seen from the ratios above that this proportion falls with advancing age and is probably little more than 50 % at ages 75 and over.

During the interval from 1936 to 1939 deaths of diabetics according to the old system of classification increased by 7 % at ages 65–74 and by 18 % at 75 and over, whereas deaths due to diabetes according to the new system showed no appreciable change at 65–74 and increased by 14 % at 75 and over. This suggests that at 65–74 the increase in death-rates in recent years has been entirely due to factors (a) and (b), increased diagnosis and mention of diabetes on death certificates, whereas at ages 75 and over these only account for a part of the continuing increase. It must be remembered that diabetics of long standing who die after 75 of an ill-defined condition of old age with mention of diabetes are assigned to the latter cause, since ill-defined conditions still give place in classification to a definite disease, even though it be only stated as contributory.

FIG. 2.   DIABETES DEATH RATES AT AGES 55-64, 65-74, 75 AND OVER, PER MILLION LIVING.
1861-70 TO 1940-41.
(NOTE. THE VERTICAL SCALE IS ONE TENTH OF THAT USED FOR EARLIER AGES.)

MALES.

75 & OVER.
65 - 74
55 - 64
75 & OVER
55 - 64
65 - 74

FEMALES.

75 & OVER
65 - 74
55 - 64
75 & OVER
55 - 64
65 - 74

2000   1500   1000   500   0   1500   1000   500   0

1861   1871   1881   1891   1901   1911   1921   1931   1941

SUGAR RATIONING.   INSULIN TREATMENT USED.

Note. The vertical lines in Figs. 1–4 represent the ends of the years indicated in the scale at the foot.

FIG. I. DIABETES DEATH RATES AT AGES 0-24, 25-34, 35-44, 45-54, PER MILLION LIVING.
1861-70 TO 1940-41.

MALES.

45-54
35-44
25-34
0-24 (STANDARDIZED)

FEMALES.

45-54
35-44
25-34
0-24 (STANDARDIZED)

200   150   100   50   0   150   100   50   0

1861   1871   1881   1891   1901   1911   1921   1931   1941

SUGAR RATIONING.   INSULIN TREATMENT USED.

FIG. 4. DIABETES. STANDARDIZED MORTALITY OF MALES PER CENT OF THAT OF FEMALES AT AGES UNDER AND OVER 55, 1861-70 TO 1940-41.

FIG. 3. DIABETES DEATH RATES (STANDARDIZED) AT AGES UNDER AND OVER 55 IN SEPARATE YEARS 1911-1941.

The general conclusion seems to be that in the immediate pre-war period there was no longer any real increase in diabetes mortality in progress at any age.

The deaths at all ages since 1936, according to the new classification and including non-civilians, have been as follows:

		1936	1937	1938	1939	1940	1941	1942	1943
Males:	January–March	—	—	484	572	721	602	528	444
	April–June	—	—	426	443	474	469	421	—
	July–September	—	—	395	374	397	351	305	—
	October–December	—	—	445	499	457	400	375	—
	Year	1899	1910	1750	1888	2049	1822	1629	—
Females:	January–March	—	—	858	962	1050	987	860	786
	April–June	—	—	707	775	764	717	678	—
	July–September	—	—	617	725	665	605	561	—
	October–December	—	—	800	811	824	734	699	—
	Year	3194	3196	2982	3273	3303	3043	2798	—
Persons:	Year	5093	5106	4732	5161	5352	4865	4427	—

The severe conditions of the March quarters of 1940 and 1941 probably hastened the deaths of some diabetics, as they did of other persons with chronic disorders. The percentages of the annual deaths registered in the March quarters of the five years 1938–1942 were, respectively, 28, 30, 35, 33, 32 for males and 29, 29, 32, 32, 31 for females. Making allowance for this, it appears that if comparison is made always with the corresponding season of the year a decline in deaths to levels below those of the immediate pre-war period set in about the middle of 1941 and has continued since without interruption for both sexes. It seems probable that this may be the beginning of a considerable fall, comparable with that which occurred from 1916 onwards, and attributable to food rationing. It is apparent from Table (d) that at ages over 55 the rates of mortality in 1942 had fallen about 16 % below those of 1938. Whether, in view of the introduction of insulin since the last war, the eventual fall will prove to be greater or less than in 1915–20 (during which period the standardized rate fell by 21 % for females), and which ages will be chiefly affected, are interesting questions for the future.

(a) *Diabetes death-rates per million, by sex and age, England and Wales, 1861–1941*

	0–24*	25–	35–	45–	55–	65–	75 up		0–24*	25–	35–	45–	55–	65–	75 up
			Males								Females				
1861–70	12·4	44	55	83	136	181	121	1861–70	8·0	22	30	37	58	62	38
1871–80	14·0	48	69	96	182	248	172	1871–80	9·1	27	35	50	88	107	68
1881–90	16·9	59	79	135	282	399	315	1881–90	14·0	36	51	82	161	208	181
1891–00	19·5	57	87	161	347	559	474	1891–00	16·1	42	56	112	258	380	312
1901–10	22·3	59	78	160	415	731	720	1901–10	19·1	51	63	129	357	574	473
1911–20	24·9	64	82	146	399	765	839	1911–20	21·1	50	65	129	367	664	644
1921–25	20·3	51	60	117	310	695	878	1921–25	19·8	41	59	122	382	747	738
1926–30	16·5	36	46	93	335	808	1071	1926–30	15·5	32	47	120	453	927	1039
1931–35	14·8	28	36	90	323	882	1289	1931–35	15·1	29	45	121	486	1167	1286
1936–39	12·3	23	33	89	330	946	1589	1936–39	14·0	22	38	122	481	1289	1575
1940–41†	13·6	22	42	76	328	980	1620	1940–41†	16·1	25	37	113	465	1272	1530

* Standardized rate.
† Corrected to pre-1940 classification and based on age distribution of mid-1939 population (including non-civilians).

(b) *Male standardized rates expressed as percentages of female standardized rates at ages 0–54, 55 upwards, and all ages*

	0–54	55 up	All ages		0–54	55 up	All ages
1861–70	194	260	205	1921–25	105	93	97
1871–80	180	221	193	1926–30	97	85	89
1881–90	150	181	161	1931–35	86	77	80
1891–00	139	142	141	1936–39	83	77	79
1901–10	119	126	124	1940–41†	84	83	83
1911–20	120	115	118				

† See note under (a).

(c) *Standardized diabetes death-rates per million at 0–54, 55 and over, and all ages,*
England and Wales, 1861–1941

	Males			Females		
	0–54	55 up	All ages	0–54	55 up	All ages
1861–70	31	148	43	16	57	21
1871–80	36	201	54	20	91	28
1881–90	45	323	74	30	178	46
1891–00	50	429	90	36	303	64
1901–10	50	552	104	42	439	84
1911	49·8	599	108·2	42·7	502	91·6
1912	50·6	642	113·5	44·8	504	93·7
1913	53·5	631	114·9	47·3	555	101·3
1914	58·4	636	119·8	47·5	567	102·8
1915	61·8	635	122·8	44·9	599	103·8
1916	58·7	638	120·3	45·4	541	98·1
1917	47·3	533	99·0	38·0	451	81·9
1918	48·8	455	92·1	40·1	384	76·7
1919	47·9	496	95·6	41·3	429	·82·5
1920	42·7	459	87·0	39·3	442	82·2
1921	49·0	456	92·3	44·2	467	89·2
1922	51·5	517	101·0	44·4	539	97·1
1923	38·0	524	89·7	40·9	540	94·1
1924	34·5	518	86·0	32·2	561 ·	88·5
1925	32·0	496	81·4	34·6	591	93·8
1926	32·8	534	86·1	31·7	586	90·6
1927	32·2	554	87·8	32·8	675	101·1
1928	30·2	603	91·1	34·0	667	101·3
1929	35·1	599	95·1	34·7	748	110·6
1930	31·1	610	92·7	30·9	752	107·6
1931	29·5	580	88·1	33·4	762	110·9
1932	28·9	626	92·4	32·5	783	112·4
1933	28·5	628	92·3	33·5	793	114·3
1934	27·2	627	91·0	30·7	821	114·9
1935	24·2	637	89·5	30·4	844	117·0
1936	24·7	681	94·6	29·6	880	120·1
1937	26·2	680	95·7 ·	31·3	875	121·1
1938	23·7	652	90·5	27·4	848	114·7
1939	23·8	686	94·2	29·7	886	120·7
1940*	25·3	723	99·5	31·3 ·	886	122·3 ·
1941*	25·2	689	95·8	29·1	817	113·0

Corrected to pre-1940 classification and based on age distribution
of mid-1939 population (including non-civilians).

(d) *Diabetes death-rates per million in 1939–42 at ages 45–54, 55 and over (standardized),*
expressed as percentages of those in 1938, according to 1940 classification

	Males		Females	
	45–54	55 up*	45–54	55 up*
1938	100	100	100	100
1939	105	106	107	106
1940	98	114	109	104
1941	100	96	91	95
1942	91	84	74	84

* Standardized.

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