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A FURTHER REPORT ON AN INVESTIGATION INTO THE MORTALITY OF DIABETICS

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(*On behalf of the Birmingham Actuarial Society*)

THE results of the investigation from 1945 to 1959 were presented in a paper to the Institute by R. E. Hayward and B. C. Lucena (*J.I.A.* **91**, 286) and readers are referred to this for further detail on practical aspects of the investigation. This further report owes its existence to all those originally involved as well as those specifically involved in the follow-up. Professor J. M. Malins and Dr M. G. FitzGerald have continued to give us the help needed to obtain the required data from the hospital records. Those of our Society particularly involved in producing this follow-up report include B. C. Lucena, R. Betteridge, A. Roberts and M. Willett.

2. The diabetic lives in the investigation are non-paying patients under the National Health Insurance Scheme attending the Diabetic Clinic at the Birmingham General Hospital. The investigation covers patients who were first diagnosed as having diabetes mellitus between 1 January 1945 and 31 December 1959. The only exclusions are coloured lives and patients who attended the clinic on one occasion only.

3. This further report includes the data of the five years 1960–64, but with no more new patients added. The principal statistical investigations of the original report have been repeated, but some of the more detailed analyses have not been attempted.

Table 1. *Summary of Data*

	Females	Males
Number of lives	3,673	2,237
Deaths	1,579	823
Moved away	304	201
Enders	1,790	1,213
Total years exposed to risk (maximum possible exposure—20 years)	31,920	18,832

4. The inclusion of a further five years data increases the exposed to risk of the previous report from 21,145 to 31,920 for females and from 11,670 to 18,832 for males. The number of deaths is increased from 894 to 1,579 for females and from 431 to 823 for males.

5. Each patient diagnosed as a diabetic during the years 1945 to 1959 was followed-up at the end of 1964. We are indebted here to the careful and accurate work by the staff at the Diabetic Clinic which resulted in few queries. The

number of diabetic patients is 95 fewer than shown in the original report because no proper clinic records could be traced for 95 patients and it was thought best to exclude them from the investigation altogether. Included in the 'deaths' are 39 cases where there is evidence of death but uncertainty as to the year, and included in the 'moved away' are 107 cases assumed moved but with no complete details. Similar assumptions are made as in the original report for these cases.

6. The mortality rates of the West Midlands Conurbation from the Registrar General's Report following the 1951 Census are again used to calculate the expected deaths. This has the advantage of enabling ready comparison with statistics produced on the same basis in the original report, and 1951 is more appropriate than 1961 as a central year for the investigation period.

Table 2. *Overall mortality ratios*

Year diagnosed as diabetic	Females	Males
	%	%
1945–49	204	150
1950–54	171	149
1955–59	140	130
All years	172	143

7. The mortality ratios of Table 2 confirm that female diabetics experience heavier extra mortality than males, particularly those diagnosed in the period 1945–49 for whom the extra mortality was as much again as the expected and was double the extra mortality being experienced for the same group of male lives.

8. The overall mortality ratios show good reduction in extra mortality experienced by those diagnosed more recently, although the statistics need further analysis by attained age and duration to confirm this impression. The figures show a slight worsening compared with the similar Table 8 of the original report; this is to be expected *a priori* because we are studying the same lives at longer durations and as will be shown duration does have such an effect.

9. The 1961 Census figures would be more appropriate to the diabetics diagnosed 1955–59 and observed until 1964. Comparison of actual deaths with expected using this mortality table changes the female ratio from 140 to 161 and the male ratio from 130 to 138.

10. The original report showed increasing mortality with duration convincingly. However the addition of the experience of 1960–64 to the data shows very interesting new features.

11. It would appear that the 1955–59 diabetics are not going to reach the level of extra mortality in later durations that was measured in earlier groups. In fact it seems possible that the extra mortality of the 1955–59 diabetics might not increase with duration at all. The level of extra mortality at durations 5–9 for the 1955–59 females is particularly encouraging as previous data has shown

Table 3. *Mortality ratios analysed by duration of diabetes*

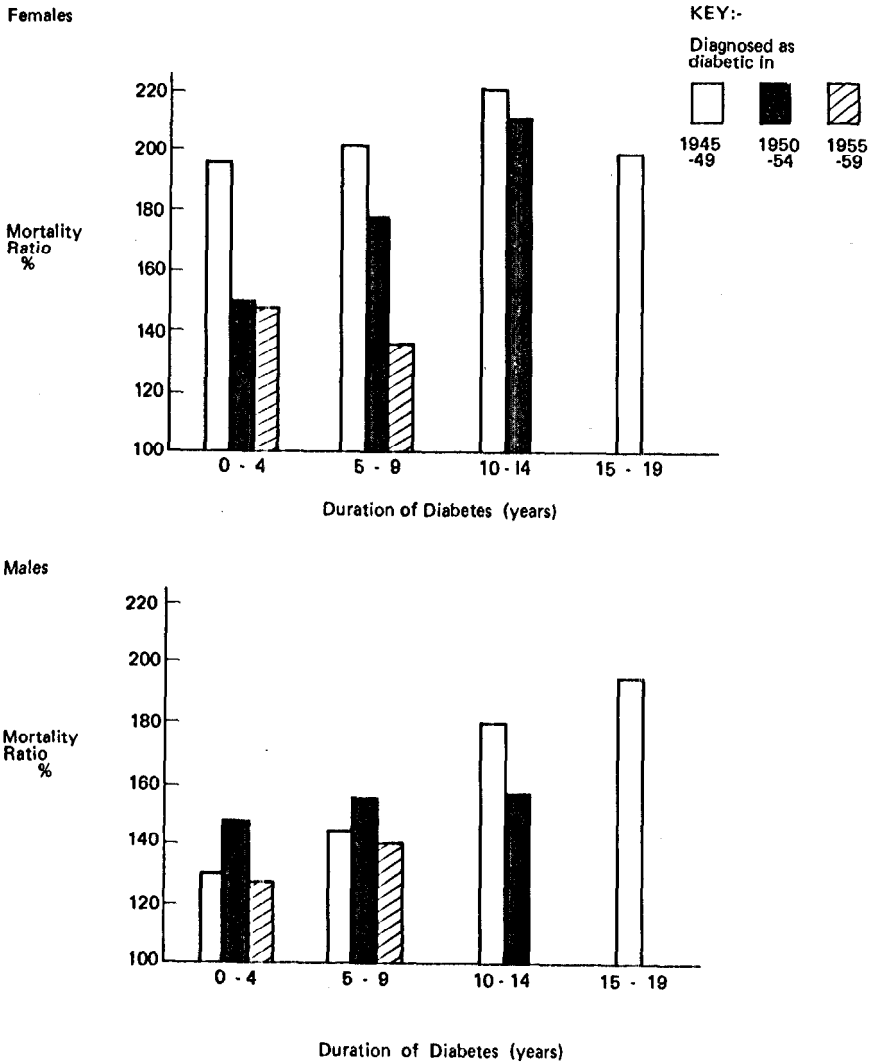
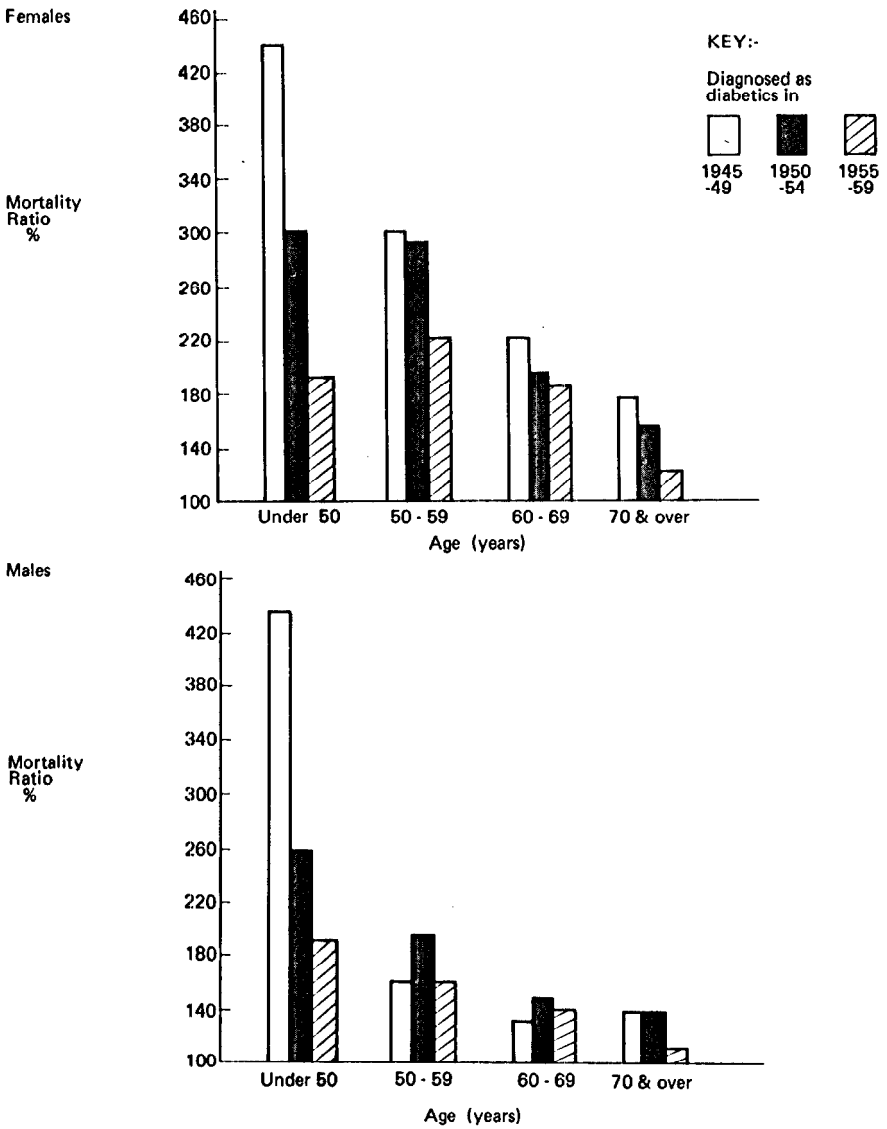


Table 4. *Mortality ratios analysed by age*



dramatic increases of mortality with duration for females. A further 5 years' data would be very interesting to see what extra mortality this 1955–59 group experience at durations 10–14. It seems possible that the scales of extra mortality previously reached in later durations could now be coming under control for the newer patients.

12. The table showing mortality ratios analysed by attained age again shows extra mortality for the patients diagnosed more recently agreeing with the same finding shown in Tables 2 and 3.

13. Most interesting is the very high extra mortality at the younger ages and the much lower extra mortality at the older ages as was evidenced in the original report. Diabetes diagnosed at the older ages is not now such a serious life shortener, particularly over age 70.

14. On the other hand diabetes contracted at younger ages shows a different picture. Particularly, the deaths under age 50, even when the duration of diabetes is small, is double the normal expected even for more recent patients. Separate figures for under age 40 are not given because the data is rather small but indications are definitely that the extra mortality is greater. The actual number of deaths at younger ages would be small but is obviously highly significant because so few deaths are expected at these ages. Perhaps more careful medical attention could be directed to the younger diabetics. Analysis of the 1950–54 diabetic patients shows 27% first diagnosed under age 50, 28% 50–59, 30% 60–69 and 15% age 70 and over.

15. Table 5 is an attempt to isolate the effect of duration of diabetes from that of age. Because of paucity of data the statistics are those for all such patients diagnosed and cannot be shown separately for the different quinquennia of

Table 5. *Mortality ratios at durations* 8–12 *years inclusive since diagnosis*

Females			
Attained age	Actual deaths	Expected deaths	Mortality ratio %
40–49	13	2·8	464
50–59	55	17·3	318
60–69	236	91·0	259
70–79	357	193·8	184
80–89	138	109·9	126

Males			
Attained age	Actual deaths	Expected deaths	Mortality ratio %
40–49	19	5·0	380
50–59	44	21·7	203
60–69	95	64·4	148
70–79	128	82·8	155
80–89	34	41·1	83

diagnosis. Even so, the data at ages 40–49 attained is rather small. On average, the data for attained ages 40–49 and durations 8–12 could be taken to represent the extra mortality experienced after 10 years of diabetes by patients diagnosed at age 35—i.e. a $q_{[35]+10}$ ratio. Similarly the data on the second line could be on average a $q_{[45]+10}$ ratio, etc.

16. The figures importantly confirm the experience of Tables 3 and 4. The mortality experienced by the patients at these durations is very heavy at the younger ages and falls steadily as the age at diagnosis increases. Also, the younger diabetics are experiencing the heavy extra mortality at early durations.

Table 6. *Mortality ratios analysed by type of treatment*

	Females		
	Year diagnosed as diabetic		
	1945–49	1950–54	1955–59
	%	%	%
All lives	204	171	145*
Those treated by insulin	246	186	165
Those treated by diet	187	160	133

* Excluding those treated orally

	Males		
	Year diagnosed as diabetic		
	1945–49	1950–54	1955–59
	%	%	%
All lives	150	149	126*
Those treated by insulin	218	167	183
Those treated by diet	129	137	105

* Excluding those treated orally

17. Each patient was classified according to the treatment being given after 1 year, thus allowing time for the type of treatment to be settled. As before, the treatment was not known for a number of patients but the previous investigation showed the overall mortality experienced by those for whom treatment was known was in line with the ratios for all patients.

18. The extra mortality of those treated by insulin is heavier than those treated by diet only. This we expect because only the milder diabetics are controlled by diet alone.

19. What is not necessarily to be expected is that, taking the 'all lives' as the average for the group, the extra mortality experienced by insulin patients above this average is considerably higher for males than females. This feature was not so pronounced in the previous results. Conversely the male patients treated by diet show better results than the females.

20. Only the 1955–59 patients had oral treatment. Table 6 excluded these patients. Table 7 is a detailed analysis of the 1955–59 patients including those treated orally. The figures for each category are based on a considerable number of deaths and therefore can be expected to be reliable.

Table 7. *Mortality ratios analysed by type of treatment for diabetics diagnosed 1955–59 only*

	Females Actual deaths	Expected deaths	Mortality ratio %
All lives	381	271	140
Those treated by insulin	117	71	165
Those treated by diet	200	151	133
Those treated by oral drugs	56	49	117
	Males		
	Actual deaths	Expected deaths	Mortality ratio %
All lives	273	209	130
Those treated by insulin	85	47	183
Those treated by diet	125	119	105
Those treated by oral drugs	60	40	151

21. The difference between the mortality experience of females and males on this oral treatment is startling. For females the extra mortality of only 17% above expected is much lower even than those treated by diet, and shows the importance of continuing the statistical work. This figure must encourage this form of treatment for females particularly. For males the experience is rather

Table 8. *Distribution of causes of death*

Codes	Description of causes	Actual distribution of deaths		Expected distribution of deaths	
		Female %	Male %	Female %	Male %
1 to 138	Infective and parasitic diseases	·7	1·3	3·5	5·4
140 to 239	Neoplasms	10·6	12·2	15·4	16·5
260	Diabetes	8·7	7·8	1·0	·4
330 to 340	Diseases of nervous system and sense organs	15·1	11·1	13·5	9·6
400 to 468	Diseases of circulatory system	48·1	48·6	35·2	30·2
470 to 527	Respiratory diseases	8·1	8·4	14·4	19·1
540 to 581	Diseases of the digestive system	1·5	2·3	2·5	3·6
590 to 599	Diseases of the genito-urinary system	·5	1·5	1·0	2·3
800 to 969	Accident, Suicide	2·3	1·3	3·0	4·1
Remainder	Others	4·3	5·3	10·5	8·8

different. The extra mortality is lower than the insulin patients but much higher than those treated by diet. Naturally, the figures are very much influenced by the choice of which patients are put on the treatment by the doctors.

22. As explained in the original report the cause of death was coded according to the International Code of Causes of Death. As far as possible the work was carried out consistently, but results must be regarded carefully. The cause of death had to be entered as unknown on about 14% of deaths.

23. Table 8 uses the data in a simple manner to compare the distribution of deaths over the period with the expected distribution according to the West Midlands Conurbation data for 1951.

24. The table illustrates the very heavy deaths experienced from cardiovascular disease, nearly one out of every two deaths being attributed to this cause.

SUMMARY

25. In conclusion, the principal findings of the investigation are:

(1) female diabetics experience heavier extra mortality than males, but the extra mortality of diabetics diagnosed 1955–59 is lower than those diagnosed 1945–49 and particularly the very heavy extra mortality for females has been reduced substantially.

(2) the experience analysed by duration shows a definite tendency for the mortality to increase with duration, except for the 1945–49 females where the mortality is very high even at the early durations. There is an encouraging possibility that the extra mortality of the 1955–59 entrants might not be going to increase with duration.

(3) the experience analysed by attained age shows very heavy extra mortality at the young ages for both sexes, decreasing to a low extra mortality at the older ages. The 1955–59 entrants show lower mortality especially at the young ages, but the extra mortality is still heavy.

(4) analysed by age and comparing mortality at the same durations confirms the worse position of young diabetics very emphatically.

(5) comparing the experience of different treatments shows heavier mortality than average for male lives by insulin than for females. Male patients treated by diet have very favourable experience.

(6) the 1955–59 patients analysed by treatment show very favourable results for females treated orally—in fact startlingly so. The same feature is not shown for males, although the experience is lighter than insulin patients.

(7) as expected, analysis of the actual causes of death of diabetic patients shows the principal risk is death from diseases of the circulatory system.

NEXT INVESTIGATION

26. Plans are already laid for a further report to include the further ten years, 1965–74. This will require more work than this follow-up because it will include new hospital patients from 1960 onwards as well as simply extending the years covered.