

## Supplementary Online Content

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**eAppendix.** Statistical Methods

**eTable 1.** Age Standardized Cause-Specific Mortality Rates

This supplementary material has been provided by the authors to give readers additional information about their work.

## Statistical Methods

There are two types of life expectancy (LE) estimation; Period LE estimates, which we have calculated, describe the expected additional years of life or LE that pertains for people alive today if mortality rates across all age bands observed today pertained throughout their lives. Cohort LE estimates attempt to go further than this and use recent trends in LE to project further improvements in survival in the future; we did not have enough long-term trend data to do this.

The person years of follow-up by age band were calculated exactly using individual level data available for the Type 1 Diabetes (T1DM) population, rather than using approximate person years based on mid-study population denominators. In Chiang's method the probability of dying in each interval conditional on having survived thus far is considered in the scheme of Bernoulli trials, with a revision to derive 95% confidence limits (CL) from Monte Carlo simulation with 10,000 repetitions on the estimated probability of death during each age interval, thus avoiding distributional assumptions and as recommended for smaller subpopulations.<sup>1</sup>

The following methods were used for deriving life table data for individuals with T1DM when renal function is preserved (i.e. eGFR maintained at  $\geq 90$  ml/min/1.73m<sup>2</sup>); i) estimating the relative risk for death associated with eGFR categories and stages of Chronic Kidney Disease (CKD) compared to preserved renal function ( $RR_i$  is the relative risk of mortality in the  $i$ th exposure stage of eGFR category or CKD stage (3-5)). A population-averaged Poisson model was fitted to the death counts to give the RRs associated with CKD adjusted for sex and linear, quadratic and cubic terms for age; ii) Within each broad age band estimating the total population attributable fraction (PAF) of deaths associated with having renal function in eGFR category 60 to 90 or CKD stage 3-5. The PAF was derived by broad age band and sex using the following equation:<sup>2</sup>  $PAF = \sum p_i(RR_i - 1) / (1 + \sum p_i(RR_i - 1))$  where  $p_i$  is the proportion of the cases in the  $i$ th exposure category; and iii) using the PAF then to provide a revised estimate of what the age sex band specific mortality rate would be if all had preserved renal function and then re-derive the life table using these rates.<sup>3</sup>

### Examination of the Loss in Life Expectancy by Age and Underlying Cause of Death

We used the discrete method of Arriaga.<sup>4,5</sup> For each fine age interval of the abridged life table, the difference in years contributed by differences in mortality rates within that age interval, known as the 'total effect' in the terminology of Arriaga, was calculated. Then, by assuming that deaths by cause are distributed uniformly within each fine age interval, the percentage contribution of each cause of death to this difference was obtained as the product of the total effect and the ratio of the difference between age-cause-specific rates for T1DM versus the non-T1DM population to the corresponding difference in all-cause mortality rates in that age interval. The results were then summarised by three broad age bands.

### Standardised Cause-specific Mortality

Within each broad age band and sex, mortality rates in both the T1DM population and the non-T1DM population were also directly standardised against the person years by fine age bands observed for the total general population including those with T1DM, and compared in eTable 1. For the T1DM, observed counts of deaths were shown alongside the standardised rates per 10,000 person years.

Where the number of deaths in a particular cell is between 1-4 the exact number has been omitted in order to comply with national data non-disclosure rules. However, the age-standardised rate calculated using the exact count is shown.

## Cause of Death Classification

Cause of death was based on International Classification of Diseases (ICD)-10 chapters or relevant sub-chapters. Suicide deaths were combined with deaths due to behavioural and mental disorder to avoid potential disclosure due to small numbers. Since ICD coding rules specify that diabetes can be recoded as the underlying cause of death when an acute coronary event is present,<sup>6</sup> deaths with diabetes as the underlying cause were revised to ischaemic heart disease (IHD) if secondary causes included codes ICD-10 I20-25, or to cerebrovascular disease when codes included I60-65. Deaths with codes for underlying causes of “DM with renal complications” and “DM with peripheral vascular complications” were revised to the renal failure and other circulatory disease categories respectively.

For the general population ICD subcodes and secondary causes of death were not provided so that the number of acute crises related diabetes deaths could not be identified directly. However, we were able to estimate these counts indirectly by using individual level data available for all those with diabetes mellitus other than type 1 diabetes on the Scottish Care Information – Diabetes Collaboration (SCI-DC) database.

## Classification of Diabetes

Clinician assigned diabetes type was accepted unless contradicted by available data on age at diagnosis and prescription history. Of those initially categorised as type 1 diabetes 11% are re-assigned, principally as type 2 diabetes. Of those initially categorised as type 2 diabetes or have labels of both type 1 and type 2 at various points <1% are reassigned as type 1 diabetes. A prescription history that contradicts type 1 diabetes is more than 1 year of non-metformin oral diabetes drug use or more than a 1 year interval from diagnosis to insulin. Those who are assigned type 1 are reassigned as type 2 if they have a contradictory drug history and age at diagnosis >40 years. Those who have labels of both type 1 and type 2 at various points in their electronic record are assigned as type 1 provided they have no contradictory history and an age of onset below 40 years. Those who are initially assigned as type 2 are reassigned to type 1 only if they have no contradictory prescription history and an age of onset below age 30 years.

## References

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**eTable 1. Age Standardized Cause-specific Mortality Rates<sup>a,b</sup>**

Underlying cause of death <sup>c</sup>		Age 20-49 years				Age 50-74 years				Age 75 and older			
		Men		Women		Men		Women		Men		Women	
		T1DM	General Pop	T1DM	General Pop	T1DM	General Pop	T1DM	General Pop	T1DM	General Pop	T1DM	General Pop
Malignant Neoplasms	Rate	7.1	2.6	6.2	3.3	66.3	54.4	61.4	42.6	211.5	236.1	165.8	156.1
	N	19	816	12	1094	59	11615	42	9787	13	10700	16	11515
Ischaemic Heart Disease	Rate	13.7	2.0	8.8	0.5	125.2	28.2	89.0	10.8	369.9	165.1	471.8	116.7
	N	37	632	17	174	116	6023	65	2495	29	7482	39	8611
Cerebrovascular Disease	Rate	0	0.6	2.7	0.4	17.9	7.4	11.3	5.6	104.1	89.8	174.6	107.1
	N	0	181	5	128	15	1570	9	1288	8	4070	15	7898
Other Circulatory	Rate	1.8	0.8	3.0	0.4	31.8	8.2	15.0	5.2	122.2	62.9	214.2	66.0
	N	5	263	6	117	26	1749	12	1185	9	2851	16	4870
Diabetic Coma and DKA	Rate	10.9	0	8.5	0.0	8.1	0.0	0	0.1	18.2	0.2	0	0.2
	N	29	0	17	<5	10	7	0	11	<5	7	0	16
Other DM	Rate	2.6	0.2	3.4	0.1	11.7	0.6	13.2	0.4	84.2	2.3	60.9	2.1
	N	7	50	7	41	11	135	11	89	6	102	5	156
Renal Failure	Rate	2.9	0.0	4.1	0.0	25.0	1.0	16.1	0.7	38.0	13.5	83.654	12.4
	N	8	<5	8	<5	23	202	13	165	<5	611	7	912
Infectious/ Parasitic Disease	Rate	1.1	0.3	2.1	0.2	7.7	1.7	7.8	1.4	0	13.1	14.7	14.1
	N	<5	92	<5	63	6	366	6	316	0	594	<5	1037
Respiratory Disease	Rate	2.6	0.5	1.7	0.5	19.8	13.2	25.4	10.9	166.9	145.4	121.1	123.5
	N	7	169	<5	157	18	2812	18	2517	11	6591	11	9107
Diseases of Digestive System	Rate	7.1	2.6	6.2	3.3	66.3	54.4	61.4	42.6	211.5	236.1	165.8	156.1
	N	19	816	12	1094	59	11615	42	9787	13	10700	16	11515
Suicide/ Mental Disorder	Rate	7.0	7.0	3.8	2.0	5.8	5.6	8.0	2.7	46.3	49.4	68.2	73.1
	N	19	2205	8	672	5	1191	6	609	<5	2239	6	5391
Other External	Rate	4.8	2.5	2.5	0.7	9.3	3.2	2.4	1.6	46.3	16.1	45.5	17.4
	N	13	792	5	214	8	679	<5	361	<5	728	<5	1281
Disease of Nervous System	Rate	1.1	0.6	1.5	0.5	4.9	3.5	10.1	3.1	0	26.4	15.4	26.3
	N	<5	177	<5	147	5	755	6	701	0	1195	<5	1938
Other Causes	Rate	4.5	0.9	4.0	0.7	14.8	4.1	14.4	3.5	46.3	35.1	22.8	46.1
	N	12	280	8	224	13	871	9	804	<5	1592	<5	3403

<sup>a</sup> Data are age standardised rates of death per 10,000 person years with number of observed deaths for age and sex groups with type 1 diabetes (T1DM) and without Type 1 diabetes (General Pop).

<sup>b</sup> Where the number of deaths in a cell is between 1-4 the exact count has been recorded as <5 but the precise rates have been reported.

<sup>c</sup> 14 mutually exclusive categories of underlying cause of death were identified based on chapters or relevant sub-chapters of ICD-10. The categories were: malignant neoplasms (C00-C97); ischaemic heart disease (IHD) (codes I20-I25); cerebrovascular disease (codes I60-69); other circulatory disease (I00-I99 excluding I20-I25 and I60-I69); diabetes mellitus (DM) (E10-E14) further split into coma or diabetic ketoacidosis (DKA) related (subcodes 0 and 1) and other diabetes mellitus; renal failure (N17-N19); infectious or parasitic disease (A00-B99); respiratory disease (J00-J99); diseases of digestive system (K00-K93); suicide or deaths of unknown intent, and mental or behavioural disorder (X60-X84, Y10-Y34, F00-F99); other external causes (all causes of external morbidity and mortality codes V01-Y98 other than intentional self-harm (X60-X84) and events of undetermined intent (Y10-Y34); disease of the nervous system (G00-G99); and any remaining codes are described as "Other causes". See methods section above for a description of the coding algorithm used to classify deaths with diabetes mellitus as the underlying cause.