Lifetime risk and years lost to type 1 and type 2 diabetes in Denmark 1996–2016

Electronic Supplementary Material

October 2020
ESM version 5

Compiled Friday 30th October, 2020, 21:52
from: `/home/bendix/sdc/DMreg/NewReg/art/yll/3rd/ESM.tex`

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1 Calculation of life expectancy and lifetime lost

This is a detailed, albeit quite short description of theory and methods underlying the calculation of the life expectancy and life lost. A complete account of the statistical analysis and all code used is available in
http://bendixcarstensen.com/DMreg/Ana2016.pdf, pp. 235 ff.

1.1 Life expectancy: definition and tradition

The life expectancy as reported by most statistics bureaus is the area under the survival curve constructed from cross-sectional age-specific mortality rates[1]. It represents the expected lifetime of a person at birth under the assumption that the age-specific mortality rates are as the cross-sectional population mortality rates during the person's life. This measure may also be reported for persons that have attained a certain age, a; the expected *residual* life time at age a. This will typically appear as a column in life tables, see *e.g.* https://dst.dk/Site/Dst/Udgivelser/GetPubFile.aspx?id=29442&sid=befudv2017, table 4.7, p. 45. The expected residual life time at age a is derived as the area under the *conditional* survival curve given survival till age a.

1.2 Lifetime lost

Lifetime lost to a disease comes in many guises, see for example [2], but here we shall use the standard definition as the difference between the expected residual lifetimes of a diseased person and a person of the same age without the disease. This is the area between the survival curves for persons with and without the disease ('years of life lost', YLL), formally:

$$\mathrm{YLL}(a) = \int_a^\infty S_{\mathrm{pop}}(u|a) - S_{\mathrm{dis}}(u|a)\,\mathrm{d}u$$

where $S(u|a)$ is the probability of surviving till age u, given attained age a. In simple cases with only one time scale and only transition from alive to dead, $S(u|a) = S(u)/S(a)$, but in more realistic situations this is not the case.

Andersen [1] also introduced the "τ-restricted" life expectancy and the corresponding lifetime lost by considering only a time span of τ after the age we refer to; formally we compare the area between the *conditional* survival curves in the interval $[a, a+\tau]$:

$$\mathrm{YLL}_\tau(a) = \int_a^{a+\tau} S_{\mathrm{pop}}(u|a) - S_{\mathrm{dis}}(u|)\,\mathrm{d}u$$

Thus, the prerequisite for calculation of life lost to a disease is the availability of survival curves for diseased and non-diseased persons. Or more specifically, *conditional* survival curves given survival to a given (set of) age(s), $S_{\mathrm{pop}}(u|a)$. Such survival curves can be derived from the age-specific mortality rates; in some cases disease incidence rates are needed too — see below.

We may compare population survival with either patients alive at a given age (prevalent cases) or patients diagnosed at a given age (incident cases). If we assume that mortality

[1] A short mathematical derivation of this can be found in https://bendixcarstensen.com/AdvCoh/relations.pdf.

rates depend on disease duration these two will be different. In our data we only have observed diabetes duration up to 20 years, and the calculations would need duration effects till at least 50 years, so we do not have the data basis for calculating life lost at a given age at diagnosis.

1.3 Constructing survival curves

The survival curve for persons with diabetes (or newly diagnosed with diabetes) at a given age is a simple transformation of the age-specific mortalities, μ_{DM} (with or without duration included):

$$S_{\mathrm{DM}}(t|a) = \exp\left(-\int_a^t \mu_{\mathrm{DM}}(u)\,\mathrm{d}u\right)$$

On the other hand, a comparison survival curve for persons without disease can be computed in three different ways:

1. use mortality rates among non-diseased persons (μ_{noDM}), transform these to a survival curve by $S_a(t|a) = \exp(-\int_a^t \mu_{\mathrm{noDM}}(u)\,\mathrm{d}u)$, and compute the integral under this curve. This will *over*-estimate the survival among persons without diabetes and hence the expected lifetime among persons without disease, because it ignores the possibility that a non-diseased person later falls ill from diabetes and thus moves to a state with higher mortality.

2. use a multistate model with *both* incidence rates of disease and mortality rates of persons with and without disease to compute a survival function for a person that is non-diseased at a given age. The survival function is computed as the probability of being alive (diseased or non-diseased) at any given age. This is the correct way of computing the expected residual life time among persons without disease at a given time, because it refers to a real-world scenario of persons alive at a given age, with no assumptions about their future life-course.

3. use mortality rates for the *entire* population. This will (slightly) *under*-estimate the survival, because the mortality rates also include persons who already has the disease at age a. If the the disease is not too prevalent or does not carry too high excess mortality this approach may be a reasonable alternative to the correct.

In our calculations we used a more elaborate version of option 2 above, using a multistate model with separate incidence rates of type 1 diabetes and type 2 diabetes, as indicated in figure 1 using different rates for causes of death.

1.4 Models for rates

We tabulated transitions (D, occurrences of type 1 diabetes, type 2 diabetes and death) and person years (Y) by current age, date of follow up (period) and date of birth (cohort) in 1-year classes (Lexis triangles). These were further classified by the current status of persons (noDM, T1D and T2D), as illustrated in figure ESM 1 and table ESM 1.

Thus for each of the left hand boxes in figure ESM 1 we have person-time Y classified by sex, age, period and cohort. Similarly, each instance of the 14 transitions (D) illustrated by the arrows in figure ESM 1 were classified by sex, age, period and cohort and the type of transition (from, to).

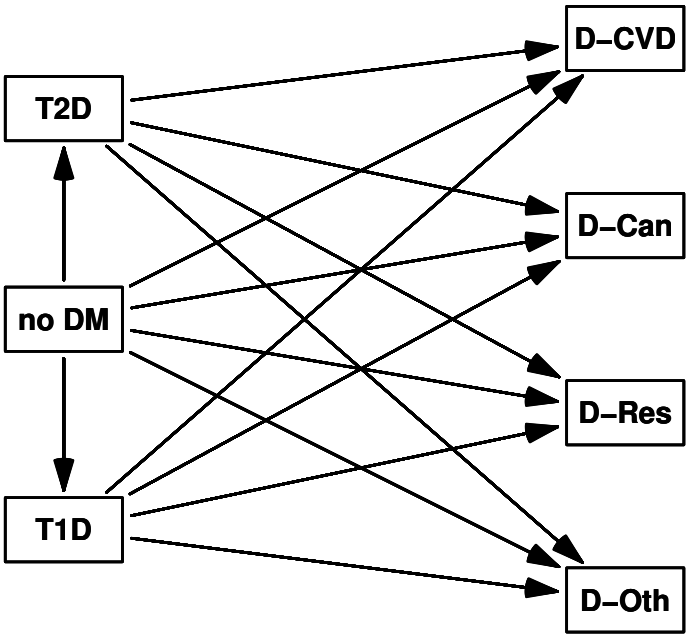

Figure ESM 1: *Multistate model used to compute the survival probabilities of persons in each of the states "no DM", "T1D" and "T2D". The right hand states refer to death from cardiovascular disease ("D-CVD"), cancer ("D-Can"), respiratory causes ("D-Res") and other causes ("D-Oth"). For persons in "T1D" and "T2D" the survival is just the probability of remaining in the state. For persons in state "no DM" at a given age the survival is the probability of being in either of the states "no DM", "T1D" and "T2D".*

For the tabulated data we fitted age-period-cohort models for all transition rates illustrated in figure ESM 1, using a Poisson likelihood for D with log person years ($\log(Y)$) as offset.

All analyses were made separately for men and women. We used natural splines (restricted cubic splines) for the effects of current age, current date (period) and date of birth (cohort).

1.5 Model based survival curves

From the parametric models for each of the 14 transitions (age-period-cohort models with smooth effects) for each sex, and from these derived the estimated cross-sectional age-specific rates at 1996-01-01, 1997-01-01,. . . , 2017-01-01, in ages 0–1200 months. Thus, in line with the normal demographic practice we used cross-sectional rates to compute measures relating to lifetime experience.

The cross-sectional rates were used to construct 1-month transition probabilities between the states, one per transition illustrated in figure 1. We used three different initial state occupancy vectors; one with probability 1 in state "no DM" (and hence 0 in the two other

states), one with probability 1 in state "T1D" and one with probability 1 in state "T2D". These were then successively multiplied by the transition probability matrices for each age, yielding the state probabilities at all ages.

The sum of the probabilities of being in any of the alive states ("noDM", "T1D", "T2D") at a given time were taken as the survival function for persons starting in each of the three transient states ("no DM", "T1D" and "T2D"). This calculation was repeated for persons starting at ages 0, 1, 2 etc. so we have survival functions conditional on being in any of the three states at these ages. The value of these survival functions were computed at 1 month age intervals till age 100 years (1200 months).

The expected lifetimes age were computed as the integral of these survival functions by adding the values of the survival function at different ages multiplied by the interval length (1 month).

The years of life lost to diabetes was computed as the difference in life expectancy between persons with diabetes and persons without.

Following Andersen [1] we used the differences in cumulative risks of each cause of death to decompose the total lifetime lost to each of the causes of death to type 1 diabetes, resp. type 2 diabetes.

1.6 Population related measures

The years of life lost to type 1 diabetes resp. type 2 diabetes are in principle unrelated to the Danish population in the sense that the measures applies to any population with incidence and mortality rates as the Danish, regardless of the age-composition of the population and patients.

But we also want to compute the population burden of diabetes in terms of the total number of years lost to diabetes in the Danish population. This can be done in (at least) two different ways:

1. the total future lifetime lost for persons alive with diabetes at a given time (the beginning of a given calendar year, say). This is the total `accumulated` future burden of diabetes among those currently alive with diabetes.

2. the total future lifetime lost among those diagnosed with diabetes during a given period (a calendar year, say). This is the *added* burden among the persons diagnosed during the last year, say.

1.7 Lifetime risk

The lifetime risk of type 1 resp. type 2 diabetes were computed by evaluating the probability of being in state T1D or T2D at age 100, using only the mortality rates from noDM, and ignoring the mortality rates from states T1D and T2D. This corresponds to ignoring anything that happens to diabetes patients after diagnosis — we are only interested in the probability of entering each of the T1D and T2D states.

2 Methodological issues

Most studies use the overall population mortality as basis for comparison (which is a reasonable approximation), and some use the non-diabetes mortality rates (which result in

an over-estimate of life time lost). Incidentally, the studies based on the NHIS [6, 3] by virtue of the data available use an empirical approximation to the correct survival probabilities for persons alive without diabetes at a given time — only mortality among persons surveyed were available, not the future diabetes occurrence.

Some studies [5, 4] indicate they used Chiang's method for calculation of the life table probabilities. This method dates back to 1968 and is aimed at compensating for irregular distribution of deaths across wide age-intervals, a natural consequence of the absence of computers in 1968. Notably it requires input of the average time lived in the interval before death for those who die in an interval, but none of the studies claiming to use Chiang's method detail how they estimated this quantity. Using a value of half the interval length will in most cases give results indistinguishable from just using the standard mathematical relationship of cumulative risk (= life table probability) as the exponential of minus the cumulative rate, particularly if rates are computed in small (1-year, say) intervals. These studies have used 5-year intervals which induce an extra inaccuracy relative to 1-year intervals. In our study we used 1 month intervals of age for calculation of transition probabilities between states.

The papers by Gregg *et al.* [3] and Narayan *et al.* [6] among others use an approach similar to ours by estimating rates in a multistate model and a Markov-chain approach to estimation of survival probabilities in different scenarios, the latter using a 1-year updating intervals. However, the updating interval should be chosen so small that the probability of transition from no diabetes to diabetes and further to death within a single interval is negligible. Which is not the cases in older ages in a 1-year interval, so these studies are likely to have a small extra bias from this.

Unlike the papers mentioned above, our study exploits the possibility from register data to build results on credible models for incidence and mortality rates (namely as smooth continuous functions of age and calendar time) as well as using modern computing to arrive at results based on continuous time models, through using 1-month updating intervals for the Markov chain. This is a major strength of our study and can be implemented in any study — using 100 1-year age classes or 1200 1-month age classes makes little difference on a modern computer.

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Table ESM 1: *Events (diabetes diagnoses and deaths) and person-years (in 1000s) in the Danish population in the 21 year study period 1996–2016, subdivided by current diabetes status.*
The three parts of the P-years column correspond to the person-years (in 1000s) in the three leftmost boxes (noDM, T1D, T2D) in figure ESM1. The 14 combinations of type of diabetes (2 types) and cause of death (4 causes) on one hand and status (noDM, T1D, T2D) on the other hand correspond to the events (arrows) in figure ESM1. Of course there are no diabetes events among persons with diabetes.

Status	Diabetes cases		Deaths by cause					
Period	T1D	T2D	CVD	Cancer	Respir	Other	All	P-years
No diabetes								
1996-1998	3,478	33,986	58,088	42,494	15,170	43,916	159,668	15,623.6
1999-2001	2,994	36,887	55,457	42,406	14,917	41,430	154,210	15,726.0
2002-2004	2,816	49,185	50,897	40,506	15,295	41,733	148,431	15,808.1
2005-2007	2,780	44,326	42,956	40,444	14,122	42,943	140,465	15,872.1
2008-2010	2,734	56,453	36,812	39,304	15,031	44,762	135,909	16,019.6
2011-2013	2,477	69,728	31,855	39,093	14,811	40,947	126,706	16,105.7
2014-2016	2,433	53,387	29,588	38,229	14,137	41,226	123,180	16,301.0
1996-2016	19,712	343,952	305,653	282,476	103,483	296,957	988,569	111,456.1
T1D								
1996-1998	.	.	868	290	137	671	1,966	68.1
1999-2001	.	.	997	365	130	643	2,135	71.2
2002-2004	.	.	835	333	175	860	2,203	73.1
2005-2007	.	.	610	397	137	950	2,094	74.4
2008-2010	.	.	501	402	183	803	1,889	73.3
2011-2013	.	.	348	284	157	643	1,432	71.0
2014-2016	.	.	243	237	113	450	1,043	70.0
1996-2016	.	.	4,402	2,308	1,032	5,020	12,762	501.1
T2D								
1996-2016	.	.	4,402	2,308	1,032	5,020	12,762	501.1
1996-1998	.	.	8,133	2,788	1,114	3,564	15,599	212.6
1999-2001	.	.	8,559	3,556	1,294	4,005	17,414	269.6
2002-2004	.	.	8,084	4,025	1,860	5,199	19,168	341.0
2005-2007	.	.	7,485	4,760	1,973	6,414	20,632	421.0
2008-2010	.	.	7,080	5,508	2,562	7,416	22,566	502.6
2011-2013	.	.	7,546	6,704	3,013	7,907	25,170	631.1
2014-2016	.	.	7,850	7,965	3,584	9,052	28,451	718.1
1996-2016	.	.	54,737	35,306	15,400	43,557	149,000	3,096.0

Table ESM 2: *Number of deaths in Denmark 1996–2016 by cause of death (10 groups)*

				Other causes						
	CVD	Cancer	Respir	Diab	Digest	Extern	Infect	Other	Renal	Urinal
All	360,278	322,704	118,944	27,196	55,029	54,769	15,277	192,737	6,989	9,831
1996	22,542	15,216	5,691	629	2,428	3,371	530	10,030	195	405
1997	22,001	15,258	5,431	1,093	2,847	3,536	374	8,718	190	444
1998	21,270	15,180	5,284	1,195	2,804	3,409	350	7,894	223	451
1999	21,458	15,445	5,628	1,367	2,886	3,441	463	7,330	242	460
2000	20,535	15,486	5,227	1,434	2,801	3,357	374	7,346	238	429
2001	20,915	15,506	5,363	1,378	2,814	3,082	390	7,695	246	432
2002	20,447	14,967	5,822	1,462	2,830	2,593	732	8,611	373	484
2003	19,834	14,926	5,860	1,360	2,742	2,543	845	8,280	439	514
2004	18,559	15,217	5,420	1,289	2,759	2,434	812	8,177	398	544
2005	17,642	15,286	5,228	1,333	2,867	2,582	725	8,135	359	540
2006	17,001	15,636	5,261	1,306	2,924	2,672	799	8,589	383	627
2007	16,080	15,128	5,661	1,311	2,677	2,525	874	10,130	402	508
2008	15,119	15,231	5,639	1,297	2,758	2,468	720	10,253	314	462
2009	14,852	15,096	6,149	1,349	2,769	2,270	831	10,315	333	493
2010	14,492	15,384	5,850	1,257	2,718	2,067	918	10,627	394	408
2011	13,475	15,529	5,846	1,377	2,478	2,198	812	9,562	334	458
2012	13,419	15,786	5,861	1,338	2,306	2,144	919	9,615	398	373
2013	12,878	15,414	6,126	1,327	2,203	2,098	1,010	10,073	398	463
2014	12,489	15,605	5,674	1,320	2,229	2,105	924	9,775	364	456
2015	12,805	15,658	5,973	1,372	2,112	1,951	969	10,507	355	463
2016	12,464	15,744	5,950	1,401	2,077	1,923	906	11,074	411	417

Table ESM 3: *Future years of life lost (1000s) among* currently prevalent diabetes patients *in Denmark at 1 January each year, and average years of life lost* per person *among these. Note that only every 3rd 1 January is shown.*

		Total YLL (1000s)			Average YLL	
	Date	T1D	T2D	DM	T1D	T2D
Men	1996	85.1	149.4	234.4	6.9	4.9
	1999	110.9	188.2	299.2	8.4	4.6
	2002	129.8	222.8	352.6	9.5	4.3
	2005	138.8	266.8	405.6	9.9	3.9
	2008	148.1	276.8	424.9	10.3	3.4
	2011	141.4	310.5	451.8	9.6	3.1
	2014	121.2	377.9	499.1	8.0	3.0
	2017	99.9	428.5	528.4	6.4	3.1
Women	1996	74.7	150.6	225.3	7.8	4.8
	1999	86.6	173.5	260.2	8.6	4.4
	2002	94.8	192.6	287.3	9.1	4.1
	2005	102.2	223.3	325.5	9.7	3.7
	2008	108.5	225.4	334.0	10.0	3.2
	2011	103.2	248.4	351.7	9.3	3.0
	2014	92.7	303.7	396.3	8.1	2.9
	2017	81.9	337.3	419.2	6.9	3.0
M+W	1996	159.8	300.0	459.7	7.3	4.9
	1999	197.6	361.8	559.3	8.5	4.5
	2002	224.6	415.4	639.9	9.3	4.2
	2005	241.0	490.1	731.1	9.8	3.8
	2008	256.7	502.2	758.8	10.2	3.3
	2011	244.6	558.9	803.5	9.5	3.0
	2014	213.9	681.5	895.4	8.0	3.0
	2017	181.8	765.8	947.6	6.6	3.0

Table ESM 4: *Future years of life lost among* persons diagnosed each year *in Denmark and average future years of life lost* per person *among these. Note that only every 3rd year is shown.*

		Total YLL			Average YLL	
	Year	T1D	T2D	DM	T1D	T2D
Men	1998	5,757	33,376	39,134	8.8	5.1
	2001	6,096	32,815	38,912	10.4	4.8
	2004	5,749	40,636	46,385	11.3	4.4
	2007	6,652	34,104	40,757	11.8	3.9
	2010	6,079	41,343	47,422	11.5	3.5
	2013	4,703	34,857	39,560	10.0	3.4
	2016	3,748	38,619	42,367	8.1	3.6
Women	1998	4,335	26,082	30,418	9.5	4.9
	2001	4,334	24,678	29,012	10.4	4.5
	2004	4,180	32,055	36,236	10.8	4.1
	2007	4,419	25,293	29,712	11.5	3.7
	2010	4,090	29,556	33,647	11.1	3.4
	2013	3,421	26,917	30,339	9.7	3.4
	2016	2,652	28,177	30,830	8.4	3.6
M+W	1998	10,093	59,460	69,553	9.1	5.0
	2001	10,431	57,494	67,925	10.4	4.7
	2004	9,929	72,693	82,622	11.1	4.3
	2007	11,072	59,397	70,470	11.7	3.8
	2010	10,170	70,900	81,070	11.4	3.4
	2013	8,125	61,775	69,900	9.9	3.4
	2016	6,401	66,797	73,198	8.2	3.6

Table ESM 5: *Years of life lost to type 1 diabetes in the Danish population by cause of death at different dates and ages. Dates refer to 1 January every 3rd year.*

		CVD		Cancer		Respir.		Other		All causes	
Date	Age	M	W	M	W	M	W	M	W	M	W
1996	20	3.4	6.2	−2.0	−1.3	0.4	−0.1	7.9	6.4	9.7	11.2
	30	3.5	6.2	−2.0	−1.1	0.4	−0.1	7.3	5.7	9.3	10.6
	40	3.7	6.1	−1.9	−1.0	0.4	−0.1	6.1	4.7	8.3	9.7
	50	4.0	5.7	−1.6	−0.8	0.5	−0.2	3.6	3.6	6.6	8.3
	60	4.2	5.0	−1.3	−0.7	0.4	−0.4	1.4	2.3	4.7	6.4
	70	3.4	3.7	−1.2	−0.4	0.1	−0.5	0.4	1.3	2.7	4.1
	80	1.7	1.8	−0.8	0.0	0.2	−0.4	−0.1	0.6	1.1	2.0
1999	20	4.4	6.2	−2.2	−1.0	0.0	0.0	9.4	6.5	11.6	11.8
	30	4.5	6.3	−2.1	−0.9	0.0	0.0	8.7	5.8	11.1	11.2
	40	4.6	6.2	−2.0	−0.7	0.0	0.0	7.4	4.9	10.0	10.3
	50	4.9	5.8	−1.7	−0.5	0.1	−0.1	4.9	3.8	8.2	9.1
	60	5.1	5.2	−1.4	−0.5	0.0	−0.2	2.3	2.6	6.1	7.1
	70	4.2	4.1	−1.2	−0.5	−0.2	−0.3	1.0	1.6	3.7	4.9
	80	2.3	2.2	−0.8	−0.1	0.0	−0.3	0.3	0.8	1.8	2.6
2002	20	4.3	5.7	−2.1	−0.6	−0.3	0.2	11.0	6.9	12.9	12.2
	30	4.4	5.7	−2.0	−0.4	−0.3	0.2	10.2	6.1	12.3	11.6
	40	4.6	5.7	−1.9	−0.3	−0.3	0.1	8.7	5.2	11.1	10.8
	50	4.8	5.4	−1.6	−0.1	−0.2	0.1	6.3	4.1	9.3	9.5
	60	4.9	4.9	−1.2	−0.2	−0.2	0.0	3.4	3.0	6.9	7.7
	70	4.1	4.0	−1.1	−0.5	−0.4	−0.1	1.8	2.0	4.4	5.4
	80	2.3	2.3	−0.8	−0.1	−0.1	−0.2	0.9	1.1	2.3	3.1
2005	20	2.5	4.2	−1.4	0.1	−0.2	0.3	12.6	8.0	13.5	12.7
	30	2.6	4.3	−1.3	0.2	−0.2	0.3	11.8	7.2	12.9	12.0
	40	2.7	4.2	−1.1	0.4	−0.2	0.3	10.2	6.2	11.6	11.2
	50	2.8	4.1	−0.8	0.6	−0.1	0.3	7.8	5.1	9.7	9.9
	60	3.0	3.7	−0.4	0.4	0.0	0.2	4.8	3.8	7.3	8.1
	70	2.4	3.2	−0.5	−0.2	−0.1	0.1	2.9	2.8	4.8	5.8
	80	1.3	1.9	−0.5	−0.1	0.1	0.0	1.6	1.7	2.6	3.5

Table ESM 5: *(cont.) Years of life lost to type 1 diabetes in the entire Danish population by cause of death at different dates and ages. Dates refer to 1 January every 3rd year.*

		CVD		Cancer		Respir.		Other		All causes	
Date	Age	M	W	M	W	M	W	M	W	M	W
2008	20	1.3	3.0	−0.3	0.5	0.1	0.5	12.8	8.9	13.9	12.9
	30	1.3	3.0	−0.2	0.7	0.1	0.5	12.0	8.1	13.2	12.2
	40	1.4	3.0	0.0	0.9	0.1	0.5	10.4	7.0	12.0	11.4
	50	1.5	2.9	0.3	1.0	0.2	0.4	8.1	5.8	10.1	10.2
	60	1.5	2.7	0.6	0.9	0.2	0.4	5.5	4.5	7.8	8.4
	70	1.2	2.3	0.4	0.1	0.3	0.3	3.4	3.5	5.3	6.2
	80	0.5	1.5	0.0	−0.1	0.4	0.2	2.0	2.3	2.9	3.9
2011	20	1.3	2.4	0.1	0.6	0.4	0.7	10.9	8.0	12.6	11.7
	30	1.3	2.5	0.2	0.7	0.4	0.7	10.2	7.3	12.0	11.1
	40	1.4	2.5	0.3	0.9	0.4	0.7	8.9	6.4	11.0	10.4
	50	1.4	2.4	0.6	1.0	0.4	0.6	7.0	5.3	9.4	9.4
	60	1.3	2.2	0.8	0.9	0.4	0.6	5.1	4.2	7.5	7.9
	70	0.9	1.9	0.5	0.1	0.5	0.5	3.3	3.3	5.2	5.9
	80	0.3	1.3	0.1	−0.2	0.6	0.5	1.9	2.2	2.8	3.8
2014	20	1.8	2.2	−0.4	0.4	0.6	0.9	8.4	6.6	10.4	10.0
	30	1.8	2.2	−0.3	0.4	0.6	0.9	7.9	6.0	10.0	9.5
	40	1.8	2.2	−0.2	0.6	0.6	0.8	7.0	5.3	9.1	9.0
	50	1.8	2.1	0.0	0.7	0.6	0.8	5.6	4.5	7.9	8.1
	60	1.5	2.0	0.0	0.6	0.5	0.7	4.3	3.6	6.4	6.9
	70	1.0	1.7	−0.1	0.1	0.6	0.7	3.0	2.9	4.5	5.4
	80	0.4	1.2	−0.3	−0.3	0.7	0.7	1.8	1.9	2.5	3.5
2017	20	2.1	1.9	−1.0	0.1	0.7	1.0	6.4	5.4	8.2	8.4
	30	2.1	1.9	−1.0	0.1	0.7	1.0	6.1	5.0	7.9	8.0
	40	2.1	1.9	−0.9	0.2	0.7	1.0	5.4	4.4	7.3	7.6
	50	2.0	1.9	−0.8	0.3	0.7	1.0	4.4	3.8	6.3	6.9
	60	1.7	1.7	−0.7	0.3	0.6	0.9	3.5	3.1	5.2	6.0
	70	1.2	1.5	−0.8	−0.1	0.6	0.8	2.7	2.5	3.7	4.7
	80	0.5	1.1	−0.6	−0.4	0.7	0.8	1.6	1.6	2.2	3.2

Table ESM 6: *Years of life lost to type 2 diabetes in the Danish population by cause of death at different dates and ages. Dates refer to 1 January every 3rd year.*

		CVD		Cancer		Respir.		Other		All causes	
Date	Age	M	W	M	W	M	W	M	W	M	W
1996	20	6.8	6.6	−0.6	1.0	−0.7	−0.1	6.4	3.8	11.9	11.3
	30	6.8	6.4	−0.4	1.0	−0.6	−0.1	5.2	3.3	10.9	10.6
	40	6.6	6.1	−0.3	1.0	−0.6	−0.2	3.8	2.6	9.5	9.5
	50	6.3	5.9	−0.2	0.7	−0.6	−0.2	2.2	1.7	7.7	8.1
	60	5.8	5.6	−0.3	0.2	−0.6	−0.3	0.8	0.8	5.7	6.3
	70	4.7	4.9	−0.3	0.0	−0.5	−0.3	−0.1	−0.1	3.8	4.5
	80	2.9	3.0	−0.3	0.0	−0.3	−0.1	−0.3	−0.3	2.0	2.5
1999	20	5.2	5.1	−0.3	1.1	−0.5	0.0	6.6	3.9	11.1	10.2
	30	5.2	4.9	−0.2	1.2	−0.5	0.0	5.5	3.5	10.0	9.6
	40	5.0	4.7	0.0	1.1	−0.4	0.0	4.1	2.8	8.7	8.6
	50	4.8	4.5	0.0	0.8	−0.4	0.0	2.7	2.0	7.1	7.3
	60	4.5	4.3	−0.1	0.4	−0.4	−0.1	1.3	1.2	5.2	5.7
	70	3.6	3.9	−0.2	0.0	−0.4	−0.2	0.4	0.3	3.4	4.0
	80	2.3	2.4	−0.2	0.0	−0.2	−0.1	0.0	0.0	1.9	2.3
2002	20	4.0	3.8	−0.1	1.2	−0.3	0.2	6.8	4.0	10.3	9.3
	30	3.9	3.7	0.0	1.2	−0.3	0.2	5.7	3.6	9.3	8.7
	40	3.8	3.5	0.2	1.2	−0.3	0.2	4.3	3.0	8.1	7.8
	50	3.6	3.4	0.2	0.9	−0.2	0.1	2.9	2.2	6.5	6.6
	60	3.3	3.2	0.1	0.5	−0.2	0.0	1.7	1.4	4.9	5.1
	70	2.6	2.9	−0.1	0.1	−0.2	−0.1	0.8	0.7	3.2	3.6
	80	1.7	1.9	−0.2	0.0	−0.1	0.0	0.4	0.3	1.8	2.1
2005	20	3.0	2.7	0.1	1.3	−0.2	0.3	6.4	3.9	9.4	8.3
	30	3.0	2.6	0.2	1.3	−0.1	0.3	5.4	3.5	8.5	7.8
	40	2.9	2.5	0.4	1.3	−0.1	0.3	4.1	2.9	7.3	7.0
	50	2.8	2.4	0.4	1.0	−0.1	0.3	2.8	2.3	5.9	5.9
	60	2.5	2.3	0.2	0.6	0.0	0.2	1.8	1.5	4.4	4.6
	70	2.0	2.0	0.0	0.2	0.0	0.1	1.0	0.9	3.0	3.2
	80	1.3	1.4	−0.2	0.0	0.0	0.0	0.5	0.5	1.7	1.9

Table ESM 6: *(cont.) Years of life lost to type 2 diabetes in the Danish population by cause of death at different dates and ages. Dates refer to 1 January every 3rd year.*

		CVD		Cancer		Respir.		Other		All causes	
Date	Age	M	W	M	W	M	W	M	W	M	W
2008	20	2.3	1.8	0.3	1.4	0.0	0.5	5.6	3.6	8.2	7.3
	30	2.3	1.8	0.5	1.4	0.0	0.5	4.6	3.2	7.4	6.9
	40	2.2	1.7	0.6	1.4	0.1	0.4	3.5	2.7	6.4	6.2
	50	2.1	1.6	0.6	1.1	0.1	0.4	2.4	2.1	5.1	5.2
	60	1.9	1.6	0.4	0.7	0.1	0.3	1.5	1.5	3.9	4.0
	70	1.5	1.4	0.1	0.2	0.1	0.2	0.9	0.9	2.6	2.7
	80	0.9	1.0	−0.1	0.0	0.1	0.1	0.5	0.6	1.4	1.6
2011	20	1.9	1.4	0.5	1.5	0.1	0.6	4.8	3.2	7.4	6.7
	30	1.9	1.4	0.6	1.5	0.1	0.6	4.0	2.8	6.7	6.3
	40	1.8	1.3	0.7	1.4	0.2	0.6	3.0	2.4	5.7	5.7
	50	1.7	1.3	0.7	1.2	0.2	0.5	2.0	1.9	4.6	4.8
	60	1.6	1.2	0.5	0.8	0.2	0.4	1.3	1.3	3.5	3.7
	70	1.2	1.1	0.2	0.3	0.2	0.3	0.8	0.8	2.5	2.5
	80	0.7	0.7	−0.1	0.0	0.2	0.2	0.5	0.6	1.3	1.5
2014	20	1.9	1.3	0.7	1.8	0.2	0.7	4.4	2.8	7.2	6.6
	30	1.9	1.2	0.8	1.7	0.2	0.7	3.6	2.5	6.5	6.2
	40	1.8	1.2	0.9	1.7	0.2	0.7	2.7	2.1	5.6	5.6
	50	1.7	1.1	0.9	1.4	0.2	0.6	1.8	1.7	4.6	4.8
	60	1.5	1.1	0.6	0.9	0.2	0.6	1.1	1.2	3.6	3.7
	70	1.2	0.9	0.3	0.5	0.2	0.4	0.8	0.7	2.5	2.6
	80	0.7	0.6	0.0	0.0	0.2	0.3	0.5	0.6	1.4	1.5
2017	20	1.9	1.2	1.0	2.1	0.2	0.8	4.1	2.5	7.2	6.5
	30	1.9	1.1	1.1	2.1	0.2	0.8	3.4	2.2	6.5	6.2
	40	1.8	1.1	1.1	2.0	0.2	0.8	2.6	1.9	5.7	5.7
	50	1.7	1.0	1.1	1.7	0.2	0.7	1.7	1.5	4.7	4.9
	60	1.6	1.0	0.8	1.2	0.2	0.7	1.1	1.0	3.7	3.8
	70	1.2	0.8	0.4	0.7	0.2	0.5	0.8	0.6	2.7	2.7
	80	0.8	0.6	0.0	0.2	0.2	0.3	0.6	0.5	1.6	1.6

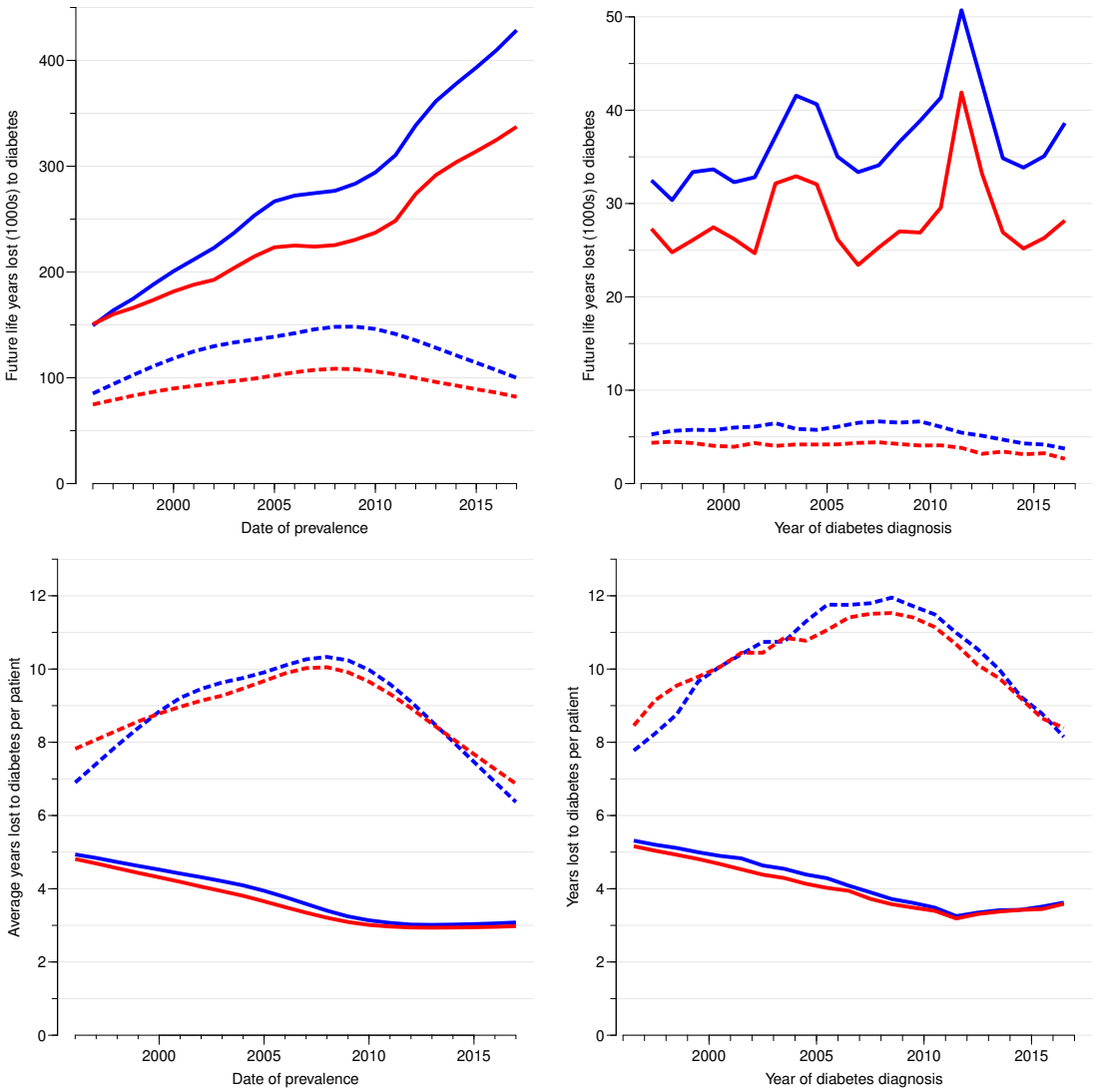

Figure ESM 2: *Upper panels:* Total *future years of life lost among all* currently prevalent *diabetes patients at each 1 January (left) and among* newly diagnosed *patients during each calendar year (right).*
Lower panels: Average *future years of life lost among currently prevalent diabetes patients each 1 January (left) and among patients diagnosed during each calendar year (right).*
Red lines are women, blue lines are men, broken lines are type 1 diabetes and full lines are type 2 diabetes.

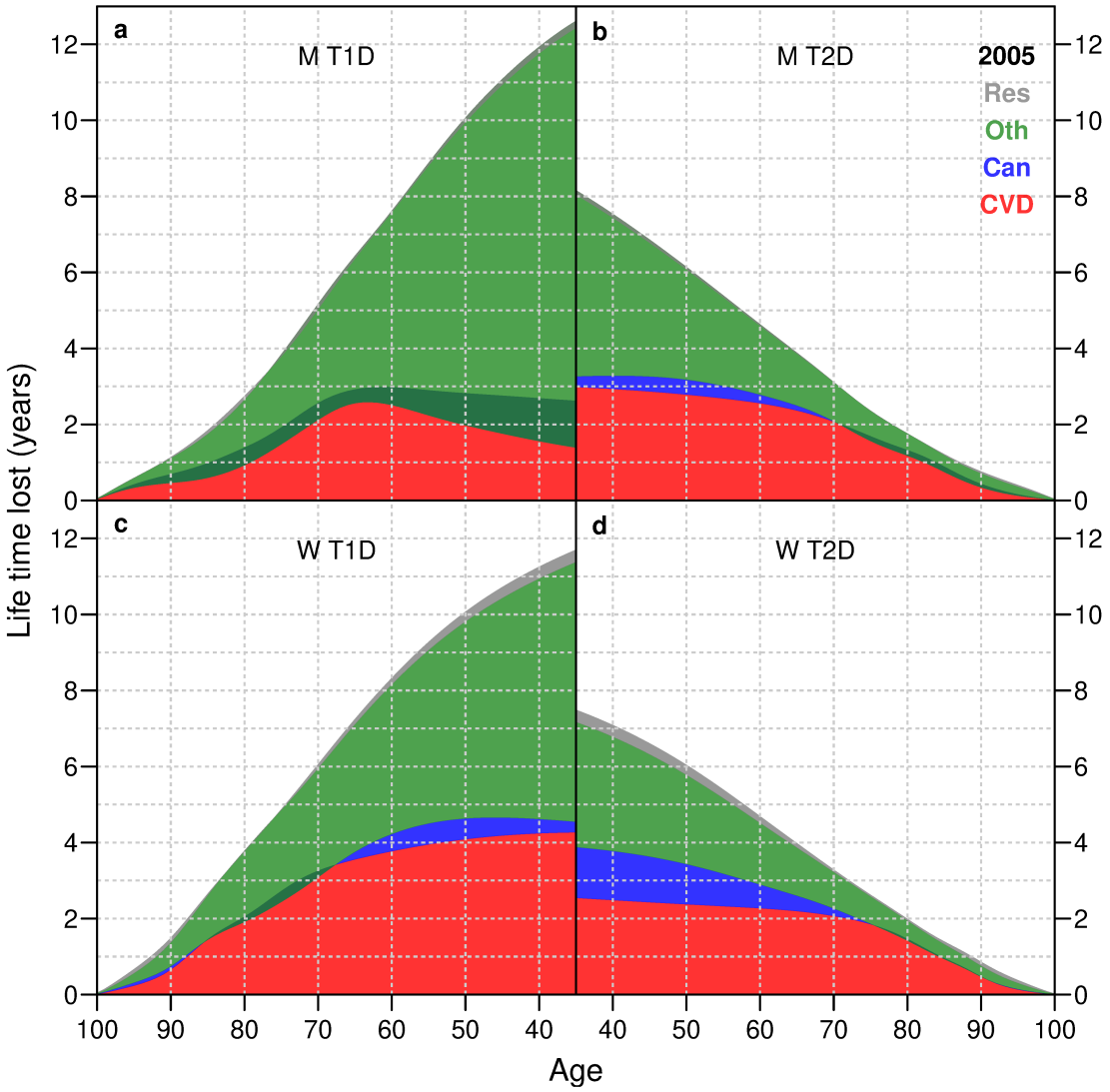

Figure ESM 3: *Years of life lost to different causes of death at 1 January 2005 by sex, type of diabetes and age.*
The dark green areas in panels a and c is equal to the negative *years of life lost to cancer for type 1 diabetes patients (it is the overlap of red, blue and green areas). This area is therefore part of both the CVD and the Other component.*
a: Men, type 1 diabetes; b: Men, type 2 diabetes; c: Women, type 1 diabetes; d: Women, type 2 diabetes.
Colors: gray: Respiratory causes; green: other causes; blue: cancer; red: CVD.

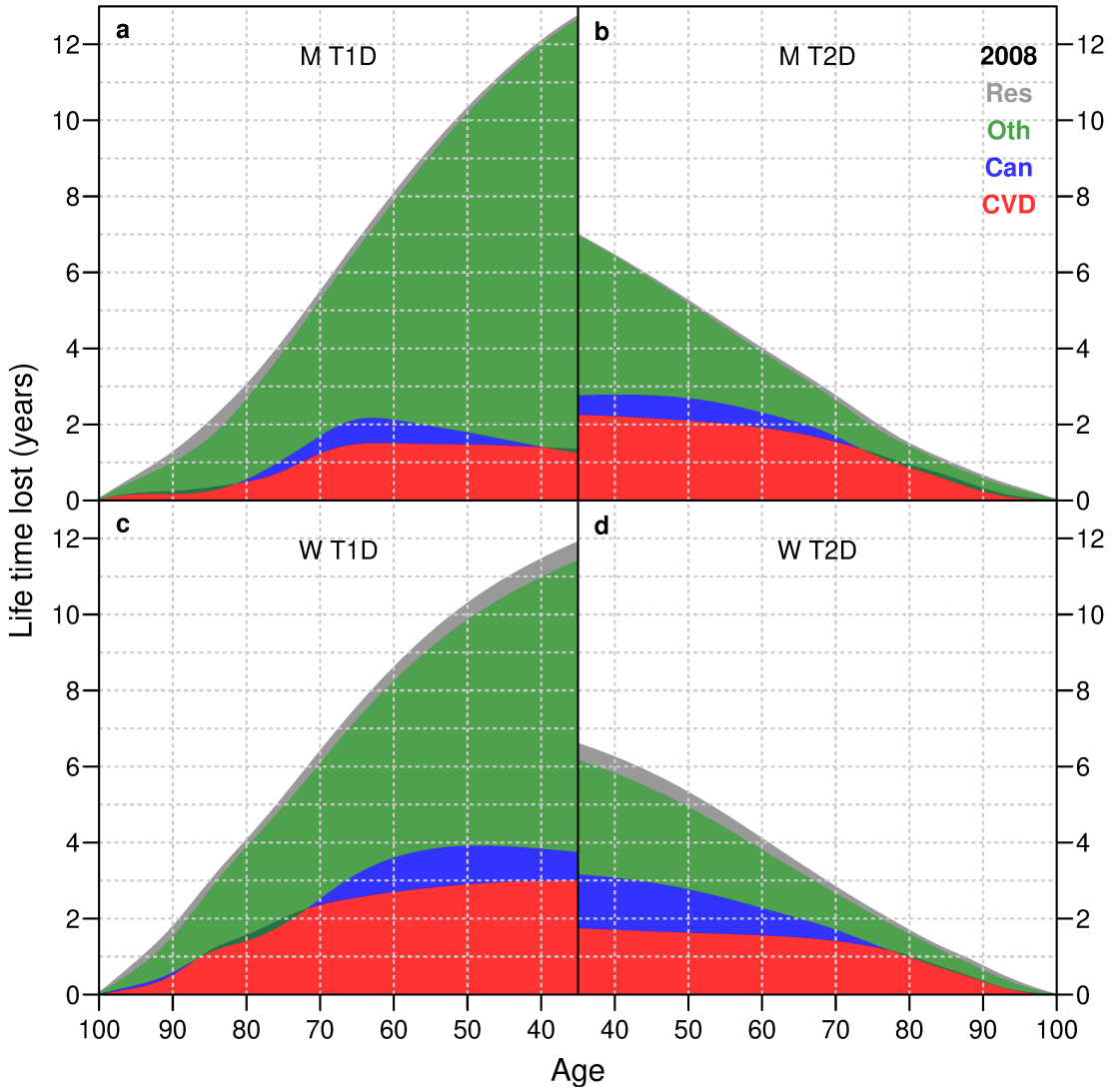

Figure ESM 4: *Years of life lost to different causes of death at 1 January 2008 by sex, type of diabetes and age.*
The dark green areas in panels a and c is equal to the negative *years of life lost to cancer for type 1 diabetes patients (it is the overlap of red, blue and green areas). This area is therefore part of both the CVD and the Other component.*
a: Men, type 1 diabetes; b: Men, type 2 diabetes; c: Women, type 1 diabetes; d: Women, type 2 diabetes.
Colors: gray: Respiratory causes; green: other causes; blue: cancer; red: CVD.

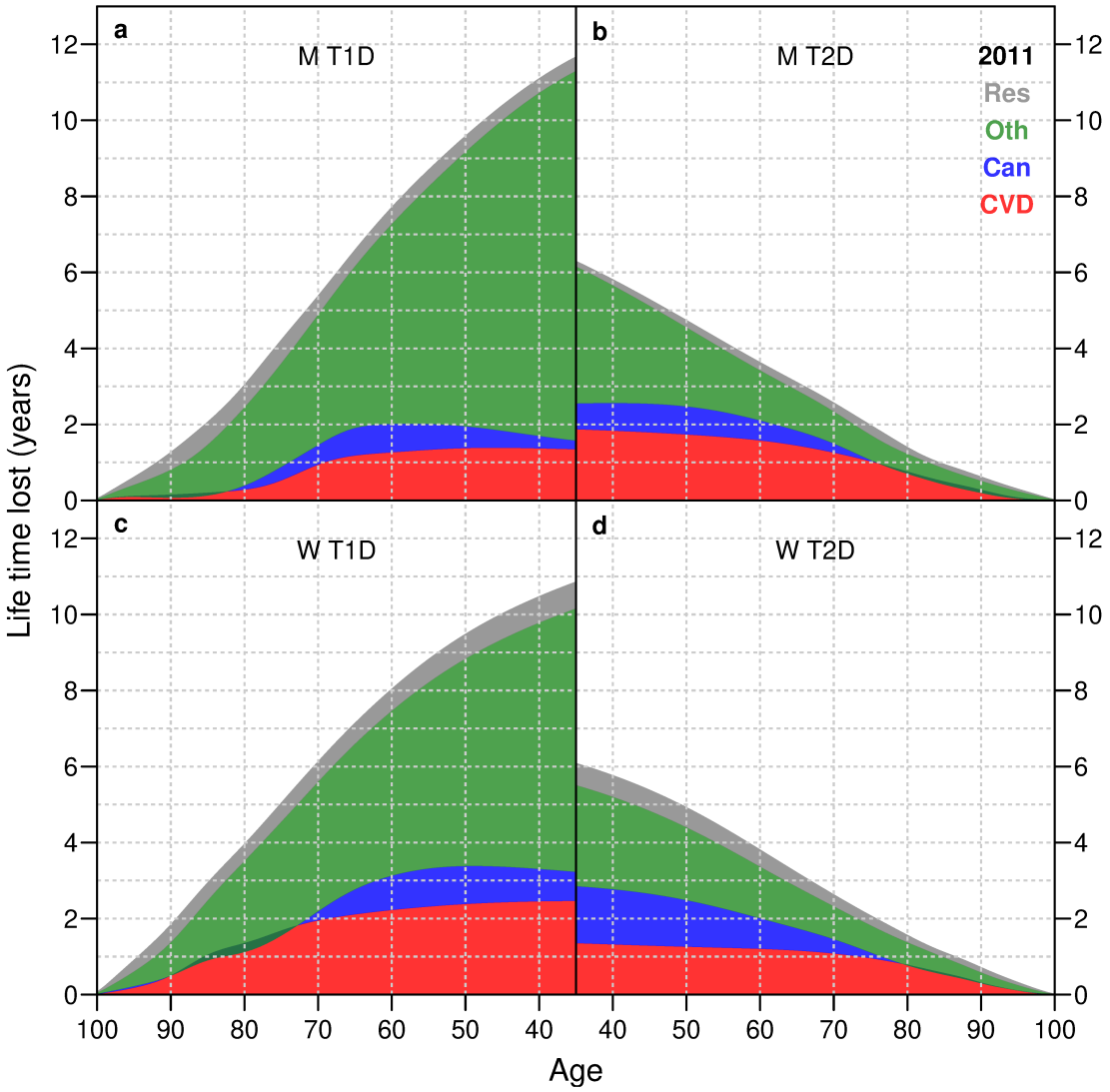

Figure ESM 5: *Years of life lost to different causes of death at 1 January 2011 by sex, type of diabetes and age.*
The dark green areas in panels a and c is equal to the negative *years of life lost to cancer for type 1 diabetes patients (it is the overlap of red, blue and green areas). This area is therefore part of both the CVD and the Other component.*
a: Men, type 1 diabetes; b: Men, type 2 diabetes; c: Women, type 1 diabetes; d: Women, type 2 diabetes.
Colors: gray: Respiratory causes; green: other causes; blue: cancer; red: CVD.

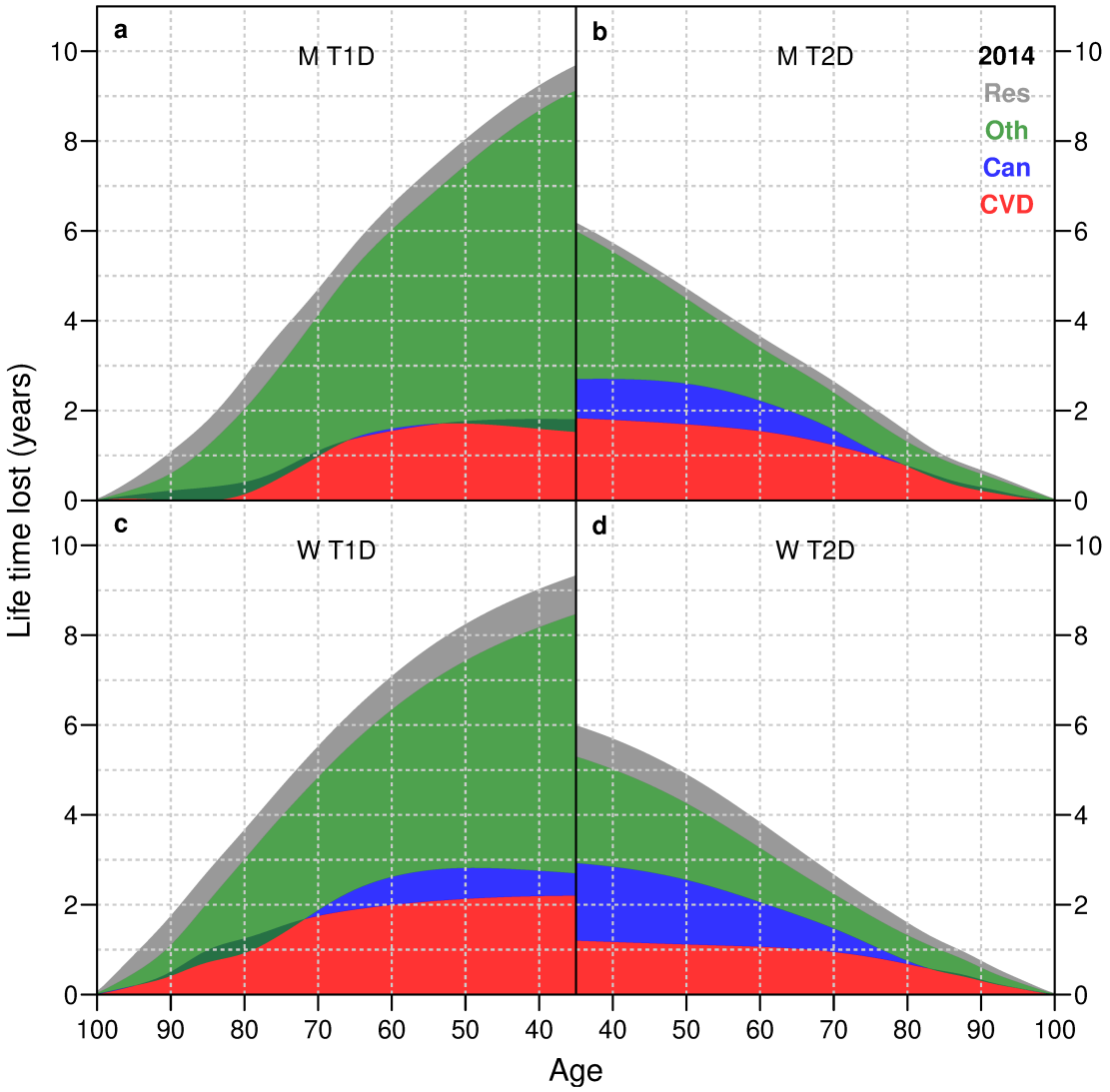

Figure ESM 6: *Years of life lost to different causes of death at 1 January 2014 by sex, type of diabetes and age.*
The dark green areas in panels a and c is equal to the negative *years of life lost to cancer for type 1 diabetes patients (it is the overlap of red, blue and green areas). This area is therefore part of both the CVD and the Other component.*
a: Men, type 1 diabetes; b: Men, type 2 diabetes; c: Women, type 1 diabetes; d: Women, type 2 diabetes.
Colors: gray: Respiratory causes; green: other causes; blue: cancer; red: CVD.

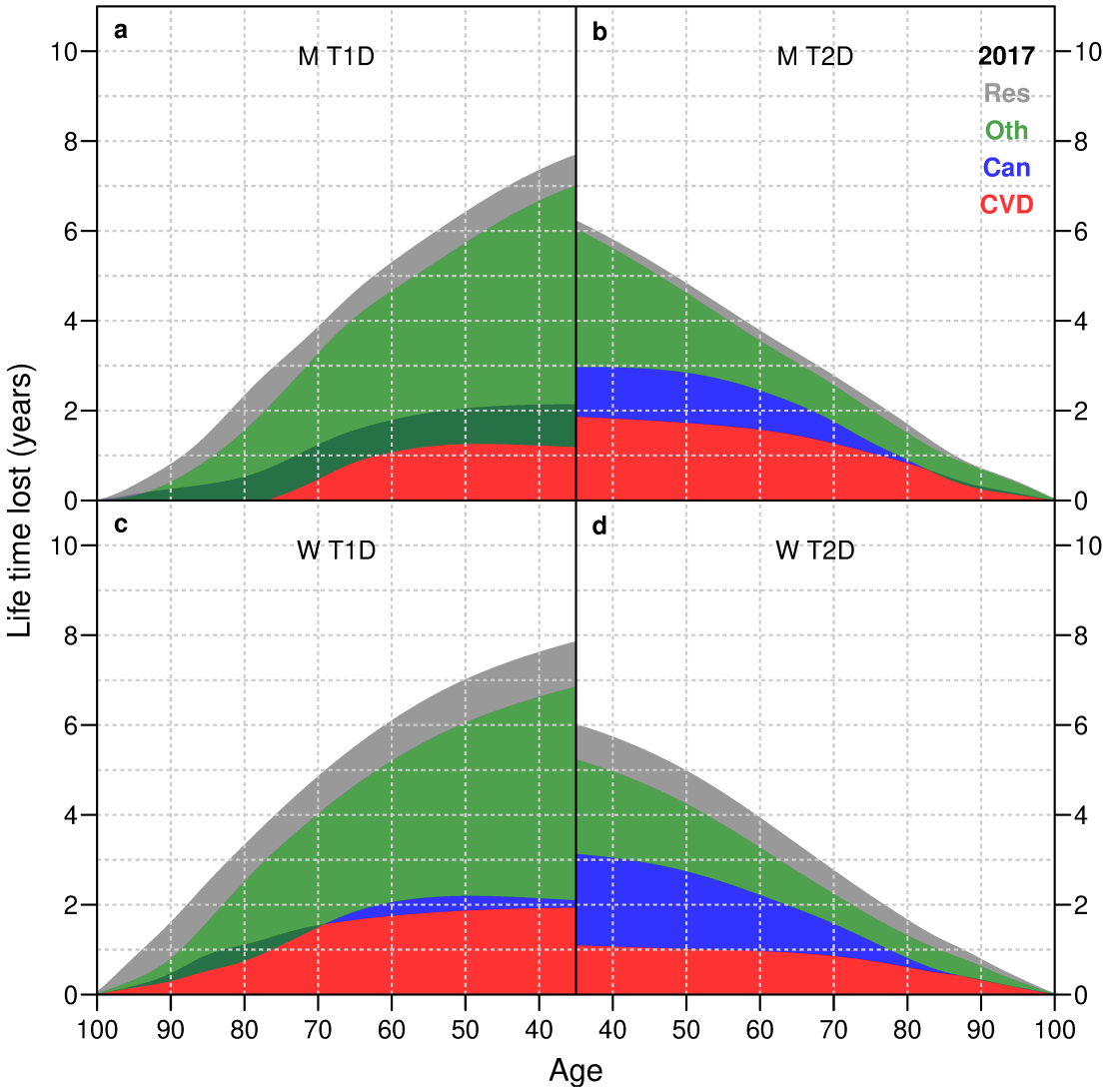

Figure ESM 7: *Years of life lost to different causes of death at 1 January 2017 by sex, type of diabetes and age.*
The dark green areas in panels a and c is equal to the negative *years of life lost to cancer for type 1 diabetes patients (it is the overlap of red, blue and green areas). This area is therefore part of both the CVD and the Other component.*
a: Men, type 1 diabetes; b: Men, type 2 diabetes; c: Women, type 1 diabetes; d: Women, type 2 diabetes.
Colors: gray: Respiratory causes; green: other causes; blue: cancer; red: CVD.

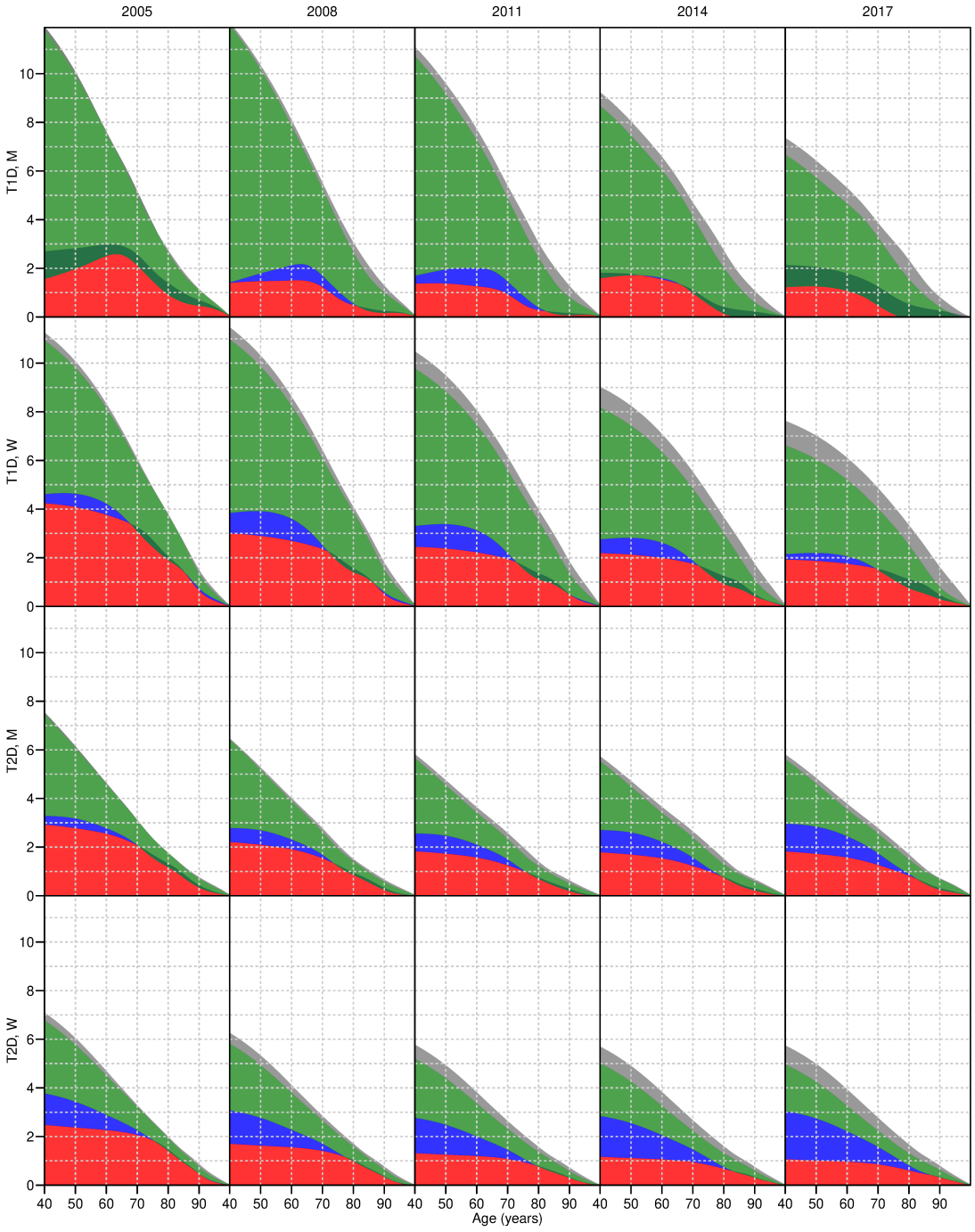

Figure ESM 8: *Years of life lost to different causes of death by date (1 January each year), sex, type of diabetes and age.*
Colours indicate cause of death: gray: Respiratory causes; green: other causes; blue: cancer; red: CVD. The dark green areas is equal to the negative *years of life lost to cancer for type 1 diabetes patients (it is the overlap of red, blue(negative) and green areas). This area is therefore part of both the CVD and the Other component.*