Diabetes Register(s)
Register collaboration

Bendix Carstensen Steno Diabetes Center Copenhagen
Gentofte, Denmark
http://BendixCarstensen.com

Danish Registers, University of Copenhagen,
November 2017

http://BendixCarstensen.com

Background for the NDR

Population surveillance

Health care surveillance

Background for the NDR

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- Monitor and describe:
  - Prevalence (no. and %)
  - Incidence (no. and rates)
  - Mortality and SMR

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Results up to 31.12.2006 reported in:

Carstensen *et al.*: The Danish National Diabetes Register: Trends in incidence, prevalence and mortality. Diabetologia, 2008

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- . . . improve accuracy of treatment information

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- All records are CPR-identified, for linkage purposes.
- Inclusion start at 1.1.1990.

Inclusion criteria for the register

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- 5 blood-glucose measurements within 1 year recorded in Register of Medicinal Product Statistics.
- 2 blood-glucose measurements per year in 5 consecutive years recorded in NHISR.
- Prescription on insulin or oral antidiabetic medicine. Metformin alone in women aged 20–39 excluded (PCOS).

Variables in the NDR (scrambeled)

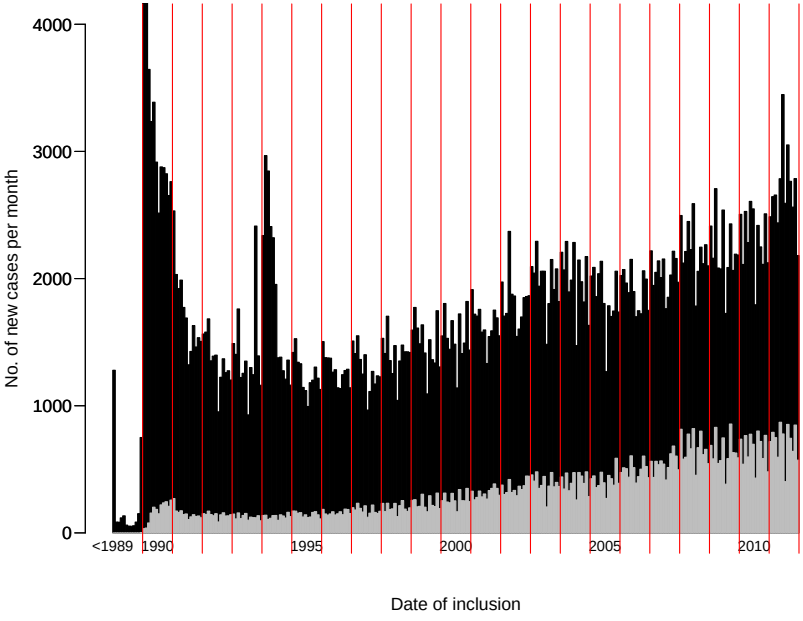
- D_FODDTO - date of birth
- C_SEX - sex
- D_INKLDTO - date of inclusion
- C_INKLAARSAG - criterion first met
- D_DODSDTO - date of death
- D_LPR - first DM diagnosis in LPR
- D_FODT - first date of chiropody
- D_BLOD2I5 - first date of 2 BG / 5y
- D_BLOD5I1 - first date of 5 BG / 1y
- D_OAD - date of 2nd OAD purchase
- D_INS - date of 2nd insulin purchase
- V_PID - person-id

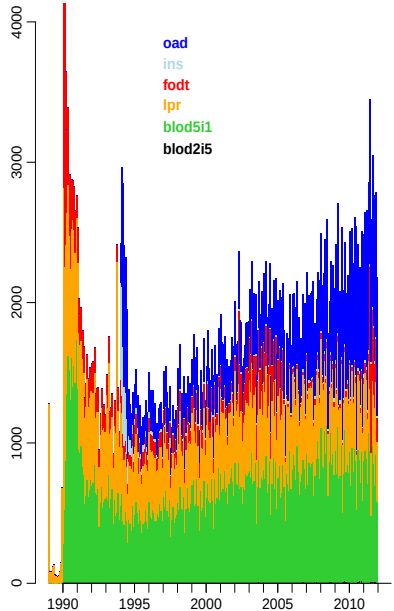
Random sample from NDR

D_FODDTO	C_SEX	D_INKLDTO	C_INKLAAR	D_DODSDTO	D_LPR	D_FODT	D_BLOD2I5	D_BLOD5I1	D_OAD
09NOV1935	K	12OCT2009	oad	.	.	.	.	.	12OCT2009
11SEP1919	M	19APR1990	lpr	22MAY1992	19APR1990	.	.	04JUL1990	.
12JUN1923	K	03JUN1998	blod5i1	22FEB2008	.	.	.	03JUN1998	.
18MAR1936	M	18APR2001	blod5i1	.	06JUN2007	23MAY2007	.	18APR2001	01JUN2001
12AUG1959	K	08OCT2008	blod5i1	.	.	.	.	08OCT2008	.
24DEC1941	M	16MAR2005	blod5i1	24FEB2007	.	.	.	16MAR2005	.
03JUL1944	M	09JAN2003	oad	.	.	.	.	12DEC2007	09JAN2003
22JAN1964	K	22JAN1997	blod5i1	.	.	.	.	22JAN1997	.
29MAR1941	K	01OCT2009	lpr	.	01OCT2009	.	.	.	22OCT2009
01JUN1949	M	06OCT2005	oad	.	.	.	.	11JAN2006	06OCT2005
15AUG1962	M	29SEP2009	oad	.	.	.	.	.	29SEP2009
02APR1949	K	18AUG2004	blod5i1	.	21JAN2009	19MAR2008	23APR2008	18AUG2004	08SEP2007
21JUL1931	K	14MAY2003	blod5i1	.	.	.	.	14MAY2003	.
08OCT1901	K	08AUG1992	lpr	20DEC1993	08AUG1992	.	.	.	.
19APR1913	K	23JAN1991	fodt	29AUG1992	.	23JAN1991	.	.	.
09MAR1913	K	03APR1998	oad	20MAY1999	.	.	.	.	03APR1998
15APR1947	M	24APR2001	oad	.	21MAY2001	.	.	.	24APR2001
12DEC1940	K	16JUL2002	lpr	.	16JUL2002	.	.	.	13JAN2006
31DEC1916	M	24MAY1991	lpr	28JUN1991	24MAY1991	.	.	.	.
21JUN1919	K	16FEB1992	lpr	15NOV1993	16FEB1992	20JAN1993	.	17JUN1992	.
31DEC1944	K	05OCT1993	lpr	.	05OCT1993	21APR2004	.	.	05NOV1994
30JUN1916	K	01FEB2006	blod5i1	18MAR2009	.	.	.	01FEB2006	.
16OCT1971	K	08DEC2004	blod5i1	.	.	.	.	08DEC2004	.
16MAY1965	K	25MAY2005	blod5i1	.	22MAY2006	.	.	25MAY2005	23NOV2005
06AUG1923	K	28OCT1998	blod5i1	01APR2004	.	.	.	28OCT1998	.
26JAN1932	M	20FEB2008	blod5i1	.	.	21MAY2008	.	20FEB2008	05MAR2008
16JUN1932	M	25FEB1998	lpr	24APR2006	25FEB1998	18NOV1998	04AUG2004	27SEP2000	03MAR2000
15FEB1914	M	22JUL1992	blod5i1	17FEB1993	.	.	.	22JUL1992	.

Random sample from NDR

D_INKLDTO	C_INKLAAR	D_LPR	D_FODT	D_BLOD2I5	D_BLOD5I1	D_OAD	D_INS	V_PID
12OCT2009	oad	.	.	.	.	12OCT2009	.	0C25D
19APR1990	lpr	19APR1990	.	.	04JUL1990	.	.	0CEC1
03JUN1998	blod5i1	.	.	.	03JUN1998	.	.	0CAF5
18APR2001	blod5i1	06JUN2007	23MAY2007	.	18APR2001	01JUN2001	.	0CCE3
08OCT2008	blod5i1	.	.	.	08OCT2008	.	.	0C2CD
16MAR2005	blod5i1	.	.	.	16MAR2005	.	.	0C47B
09JAN2003	oad	.	.	.	12DEC2007	09JAN2003	.	0C619
22JAN1997	blod5i1	.	.	.	22JAN1997	.	.	0C6F9
01OCT2009	lpr	01OCT2009	.	.	.	22OCT2009	.	0CD42
06OCT2005	oad	.	.	.	11JAN2006	06OCT2005	.	0C42B
29SEP2009	oad	.	.	.	.	29SEP2009	.	0CBE4
18AUG2004	blod5i1	21JAN2009	19MAR2008	23APR2008	18AUG2004	08SEP2007	.	0C2ED
14MAY2003	blod5i1	.	.	.	14MAY2003	.	.	0C2CD
08AUG1992	lpr	08AUG1992	.	.	.	.	.	0C5FA
23JAN1991	fodt	.	23JAN1991	.	.	.	.	0CFB0
03APR1998	oad	.	.	.	.	03APR1998	.	0C976
24APR2001	oad	21MAY2001	.	.	.	24APR2001	.	0CB64
16JUL2002	lpr	16JUL2002	.	.	.	13JAN2006	17JAN2006	0CEE1
24MAY1991	lpr	24MAY1991	.	.	.	.	.	0CB84
16FEB1992	lpr	16FEB1992	20JAN1993	.	17JUN1992	.	.	0CF20
05OCT1993	lpr	05OCT1993	21APR2004	.	.	05NOV1994	.	0CCB3
01FEB2006	blod5i1	.	.	.	01FEB2006	.	.	0C867
08DEC2004	blod5i1	.	.	.	08DEC2004	.	.	0CB44
25MAY2005	blod5i1	22MAY2006	.	.	25MAY2005	23NOV2005	.	0C52A
28OCT1998	blod5i1	.	.	.	28OCT1998	.	.	0CE21
20FEB2008	blod5i1	.	21MAY2008	.	20FEB2008	05MAR2008	.	0C758
25FEB1998	lpr	25FEB1998	18NOV1998	04AUG2004	27SEP2000	03MAR2000	30JUL2002	0CBB4
22JUL1992	blod5i1	.	.	.	22JUL1992	.	.	0C709


4000
3000
2000
1000
0
No. of new cases per month
<1989
1990
1995
2000
2005
2010
Date of inclusion


oad
ins
fodt
lpr
blod5i1
blod2i5
0
1000
2000
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4000
1990
1995
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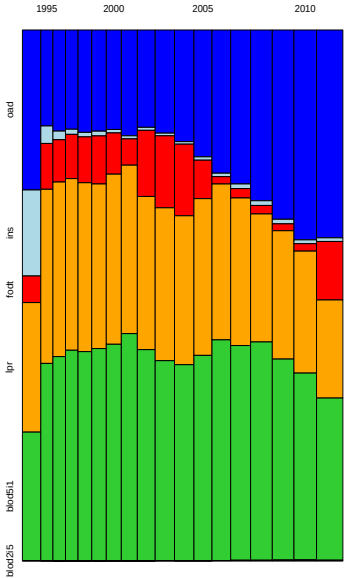
1995
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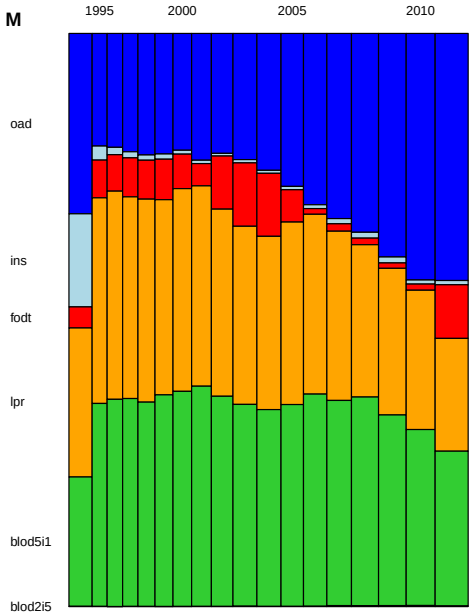
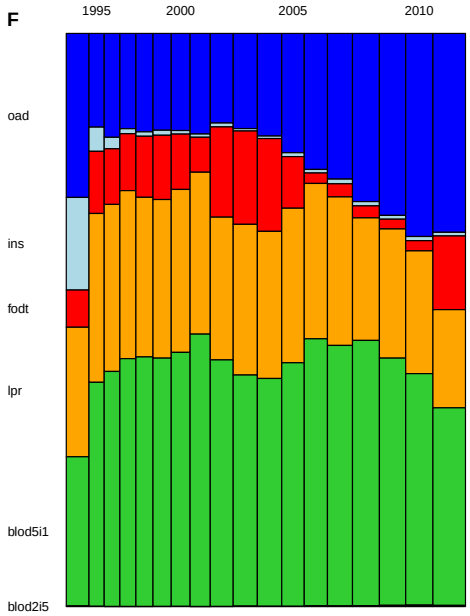

M
1995
2000
2005
2010
oad
ins
fodt
lpr
blod5i1
blod2i5


F
1995
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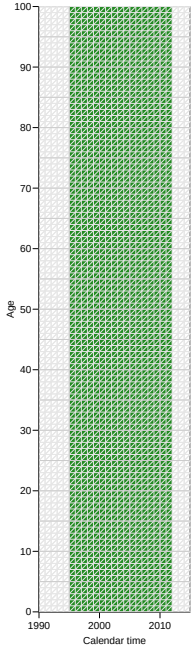
Methods: Incidence

- New cases tabulated by age and date of diagnosis (1995-2007) and date of birth, in 1-year classes.



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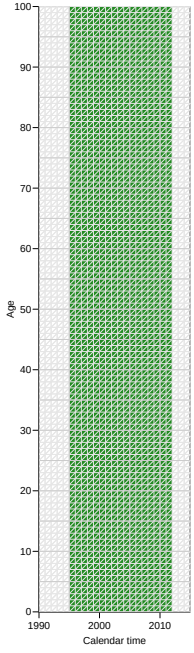

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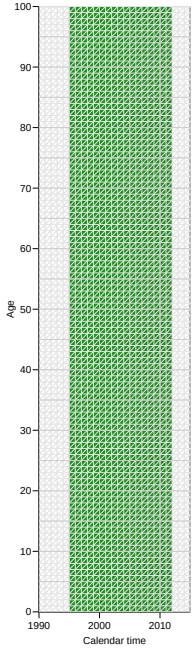
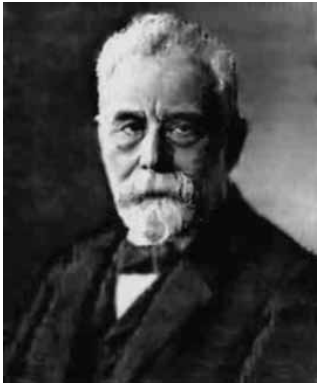
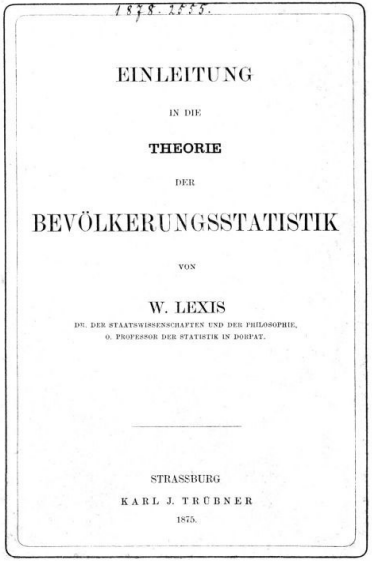
- Incidence rates analysed by Poisson-regression with smooth parametric terms in age and date of diagnosis, using log-person-years as offset.



Digression: Lexis diagram



Wilhelm Lexis (1837–1914)
German demographer, statistician and economist.



1878. 2275.

EINLEITUNG

IN DIE

THEORIE

DER

BEVÖLKERUNGSSTATISTIK

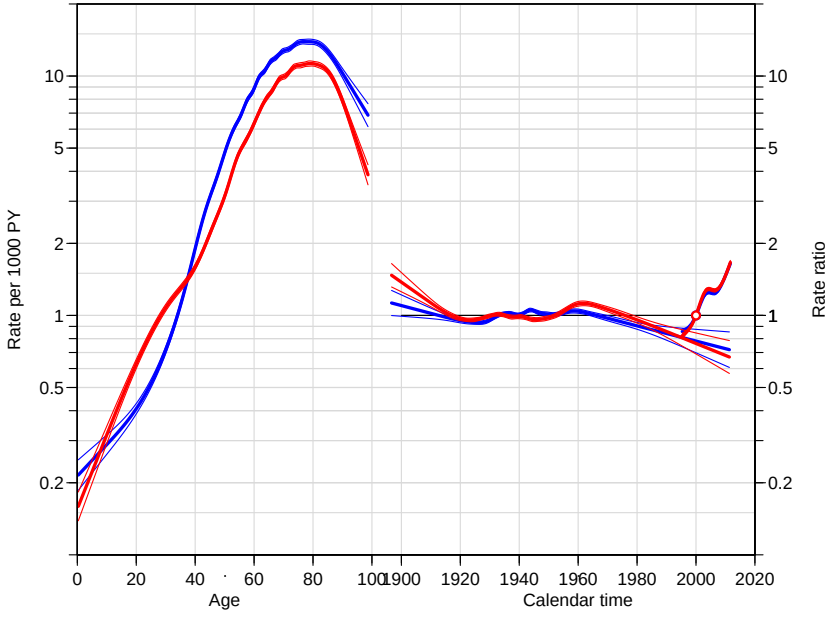
VON

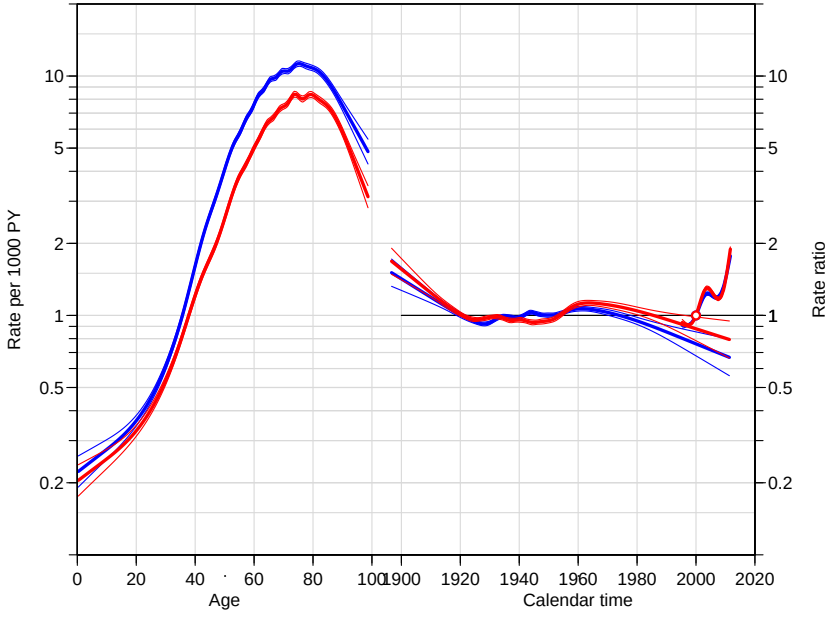
W. LEXIS

DR. DER STAATSWISSENSCHAFTEN UND DER PHILOSOPHIE,
O. PROFESSOR DER STATISTIK IN DORPAT.

STRASSBURG
KARL J. TRÜBNER
1875.

New cases in NDR	2006			2011		
Year	M	F	All	M	F	All
$\leq$ 1989	1,480	1,310	2,790	1,514	1,330	2,844
1990	21,347	24,738	46,085	21,434	24,775	46,209
1991	10,681	9,987	20,668	10,763	10,055	20,818
1992	8,554	7,855	16,409	8,463	7,786	16,249
1993	9,165	7,639	16,804	9,196	7,642	16,838
1994	12,103	10,733	22,836	11,993	10,688	22,681
1995	7,745	7,148	14,893	7,756	7,150	14,906
1996	8,015	7,388	15,403	8,016	7,388	15,404
1997	7,923	7,528	15,451	7,928	7,533	15,461
1998	8,800	8,039	16,839	8,819	8,048	16,867
1999	9,295	8,537	17,832	9,314	8,565	17,879
2000	9,614	8,881	18,495	9,620	8,883	18,503
2001	10,181	9,468	19,649	10,215	9,481	19,696
2002	11,123	10,745	21,868	11,178	10,790	21,968
2003	12,385	11,378	23,763	12,370	11,361	23,731
2004	12,465	11,465	23,930	12,472	11,477	23,949
2005	11,607	10,535	22,142	11,619	10,582	22,201
2006	12,007	10,865	22,872	12,094	10,920	23,014
2007				12,719	11,783	24,502
2008				14,005	12,663	26,668
2009				14,298	12,360	26,658
2010				14,974	12,818	27,792
2011				17,080	15,314	32,394
1995–2006	121,160	111,977	233,137	121,401	112,178	233,579
1995–2011				194,477	177,116	371,593
Total	184,490	174,239	358,729	257,840	239,392	497,232


Rate per 1000 PY
10
5
2
1
0.5
0.2
0
20
40
60
80
100
Age
1900
1920
1940
1960
1980
2000
2020
Calendar time
Rate ratio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5
2
1
0.5
0.2
0
20
40
60
80
100
Age
1900
1920
1940
1960
1980
2000
2020
Calendar time
Rate ratio
10
5
2
1
0.5
0.2

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- Incidence rates peak in ages 70–85: 1.2%/year for men, 1.2%/year for women in 2005.
- Annual increase in incidence rates over the period 1995–2004 was 5.6%, after 2004 almost flat

Glucose criteria

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- Omitting the glucose criteria:
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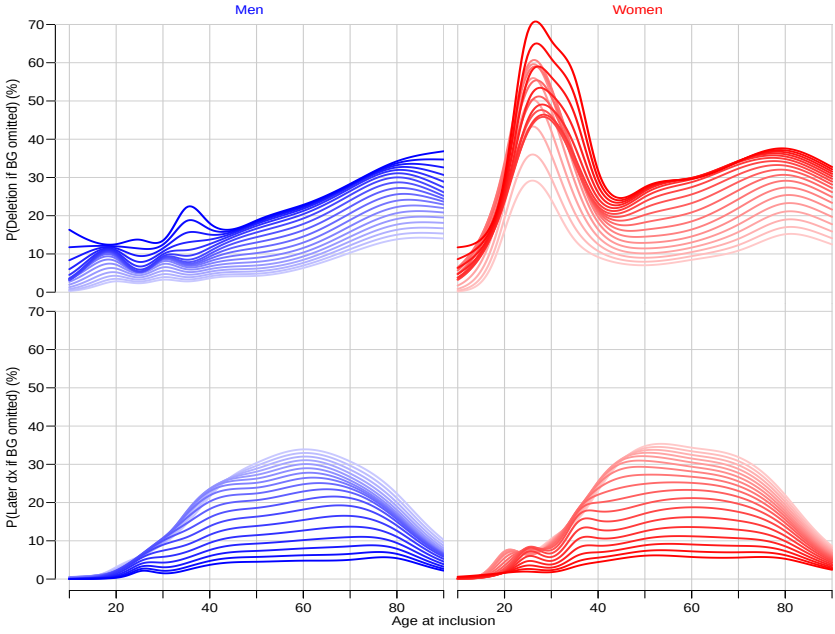
  - Some have a later diagnosis (meeting a different criterion).
- The new diagnostic criteria based on HbA1c makes the blood glucose criteria even more uncertaing.
- No consensus on how to proceed.


Men
Women
P(Deletion if BG omitted) (%)
P(Later dx if BG omitted) (%)
0
10
20
30
40
50
60
70
20
40
60
80
Age at inclusion

Methods: Prevalence

- Prevalent cases by 1 Jan 1995,. . . ,2010 tabulated by sex and 1-year age.

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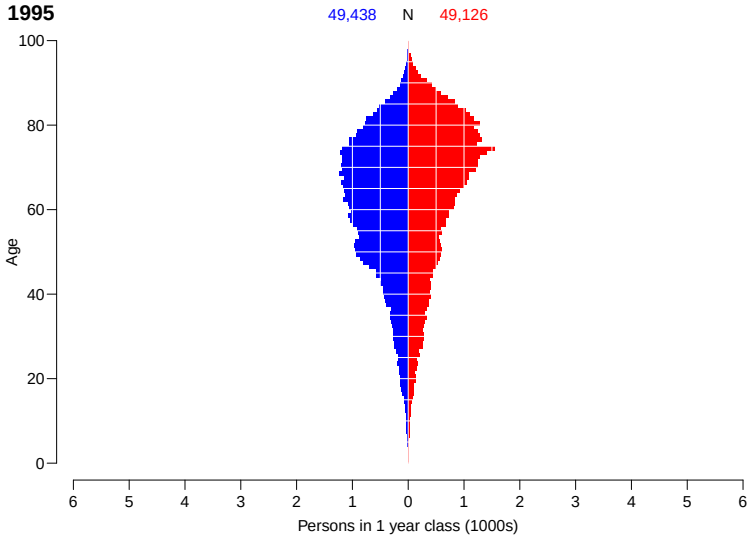
- Prevalent cases by 1 Jan 1995,...,2010 tabulated by sex and 1-year age.
- Corresponding population figures from Statistics Denmark.
- Prevalence analysed by a binomial model with log-link and the population size as denominator. Separate parametric terms used for each sex and date.

Prevalence of diabetes

	No. patients			Prevalence (%)		
1 January	M	F	All	M	F	All
1995	49,438	49,126	98,564	1.92	1.86	1.89
1996	53,443	52,631	106,074	2.06	1.98	2.02
1997	57,739	56,551	114,290	2.22	2.12	2.17
1998	61,832	60,522	122,354	2.36	2.26	2.31
1999	66,746	64,974	131,720	2.54	2.42	2.48
2000	71,798	69,692	141,490	2.73	2.59	2.65
2001	77,120	74,570	151,690	2.92	2.76	2.84
2002	82,914	79,895	162,809	3.12	2.94	3.03
2003	89,291	86,364	175,655	3.35	3.17	3.26
2004	96,706	93,199	189,905	3.62	3.42	3.52
2005	104,149	100,227	204,376	3.89	3.67	3.78
2006	110,581	106,028	216,609	4.12	3.87	3.99
2007	117,328	112,018	229,346	4.35	4.07	4.21
2008	124,501	118,726	243,227	4.59	4.30	4.44
2009	132,847	126,295	259,142	4.86	4.54	4.70
2010	140,940	133,318	274,258	5.14	4.78	4.96
2011	149,702	140,507	290,209	5.43	5.01	5.22
2012	160,352	150,309	310,661	5.80	5.34	5.57

Prevalence of diabetes — age distribution



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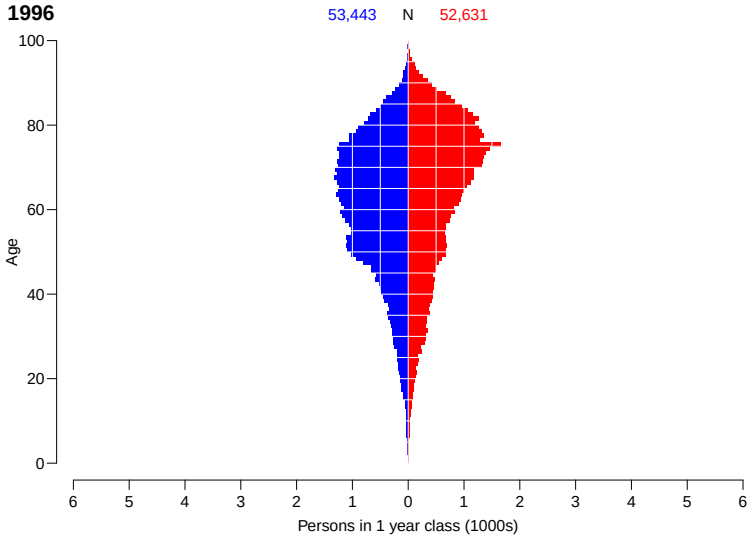

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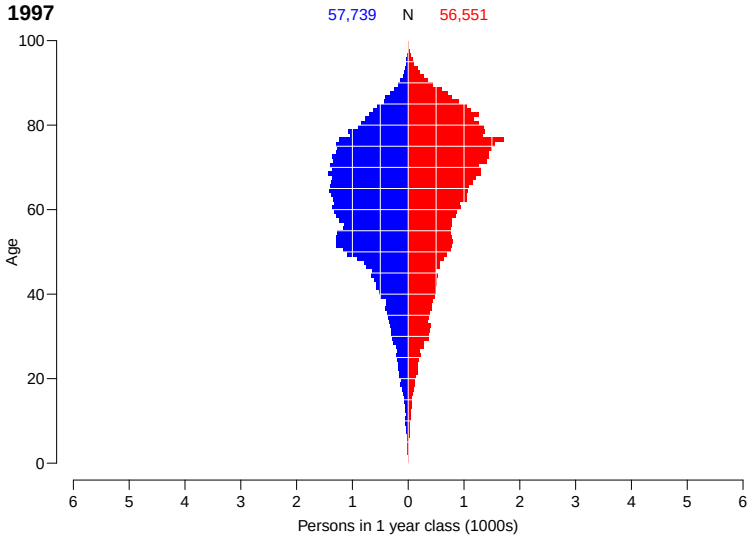

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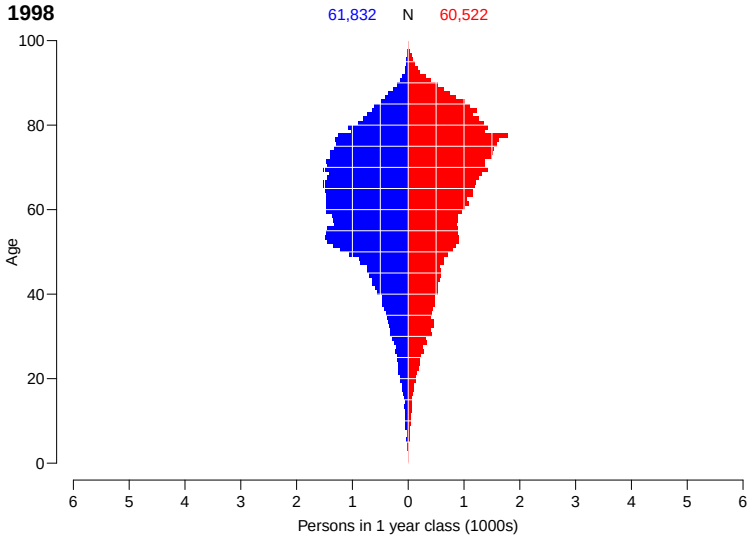

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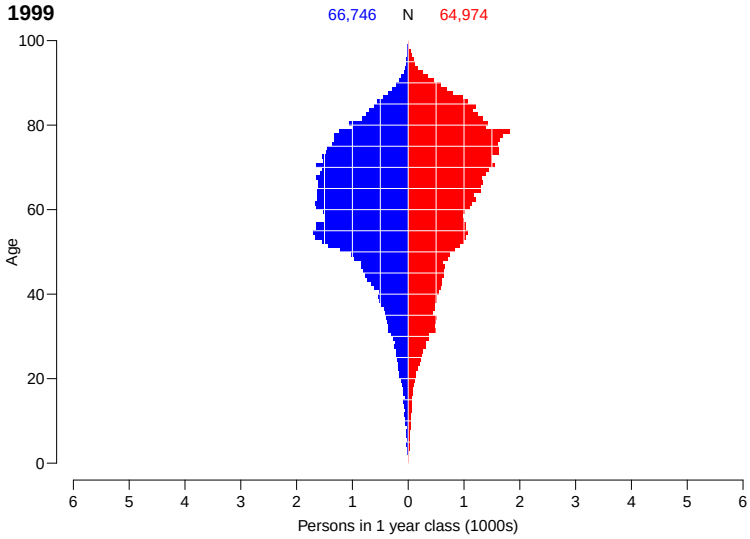

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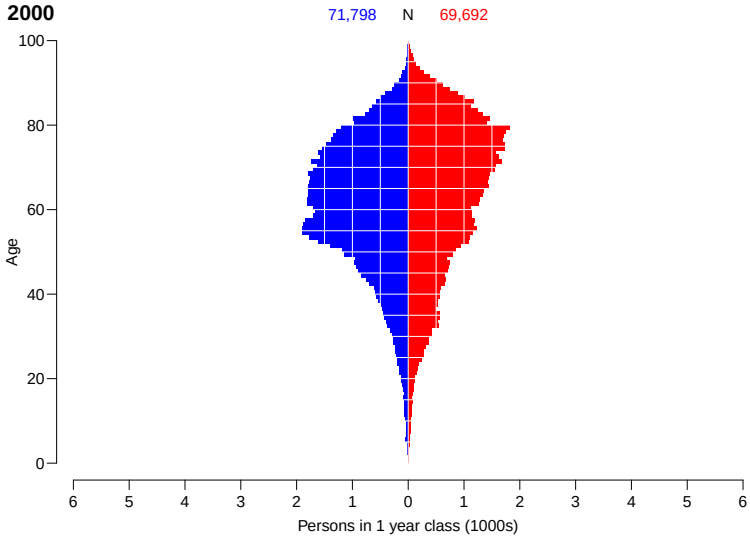

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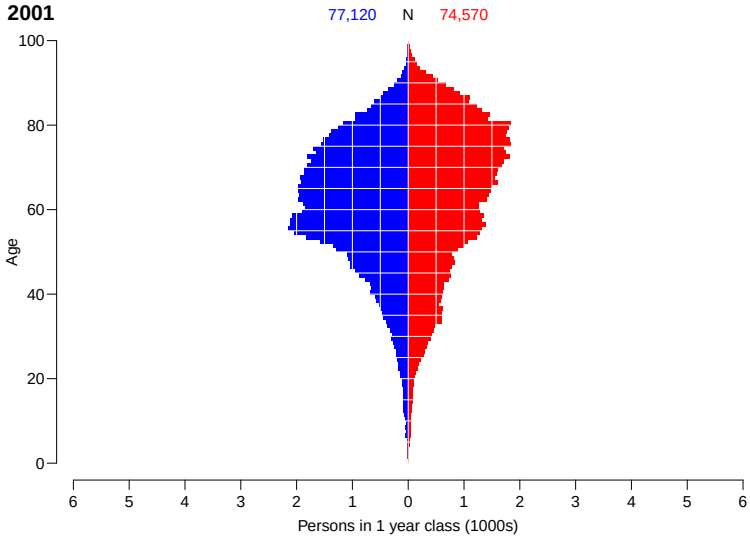

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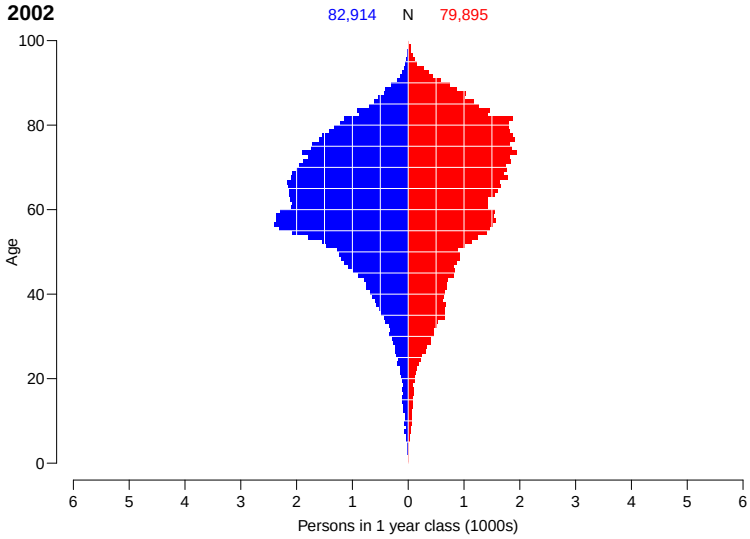

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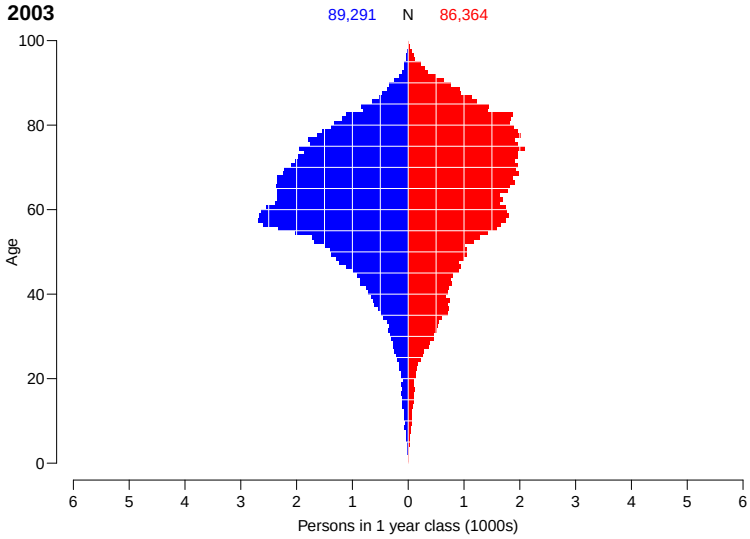

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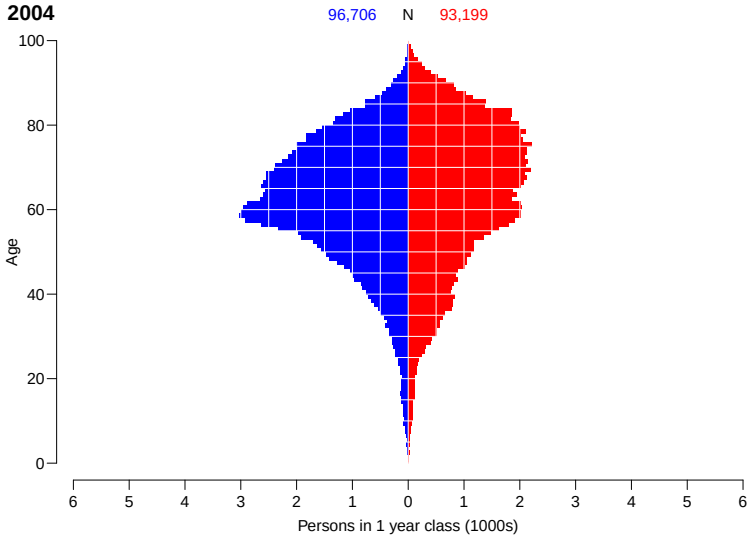

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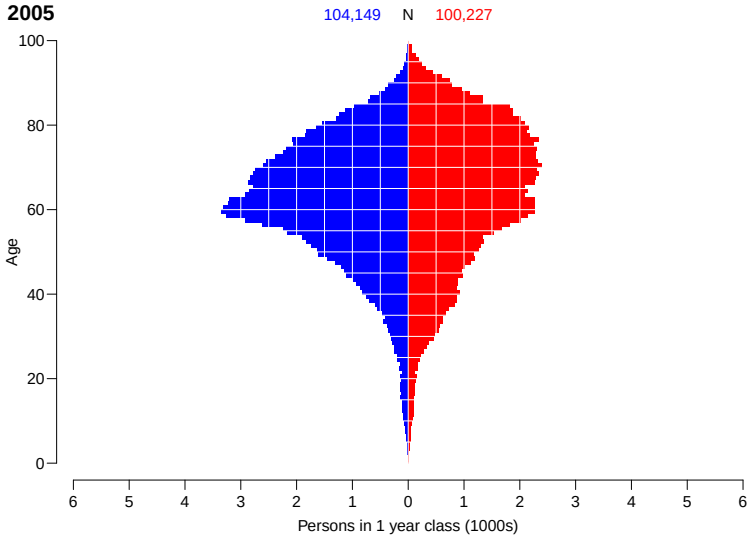

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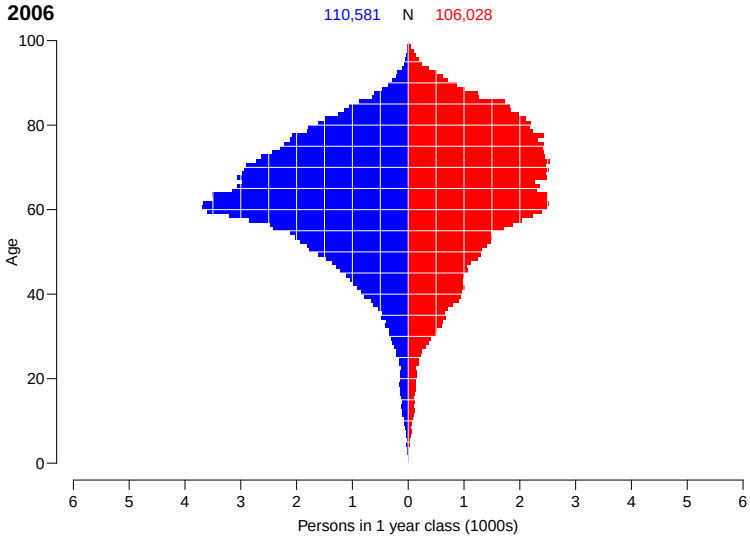

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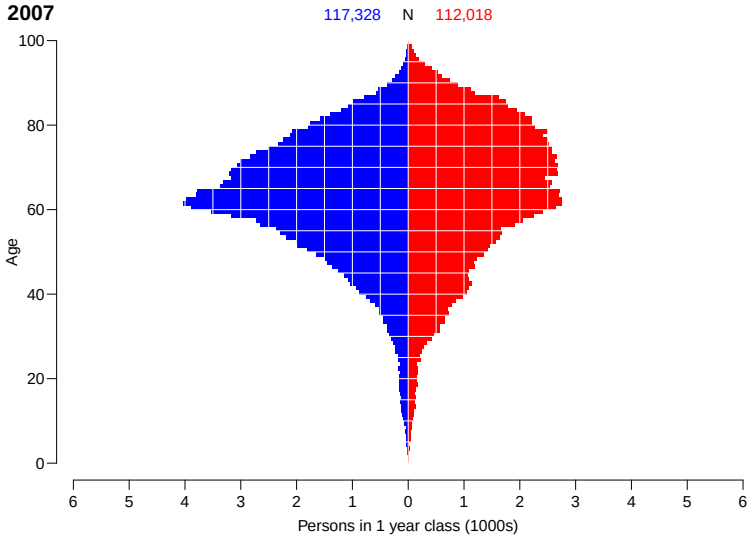

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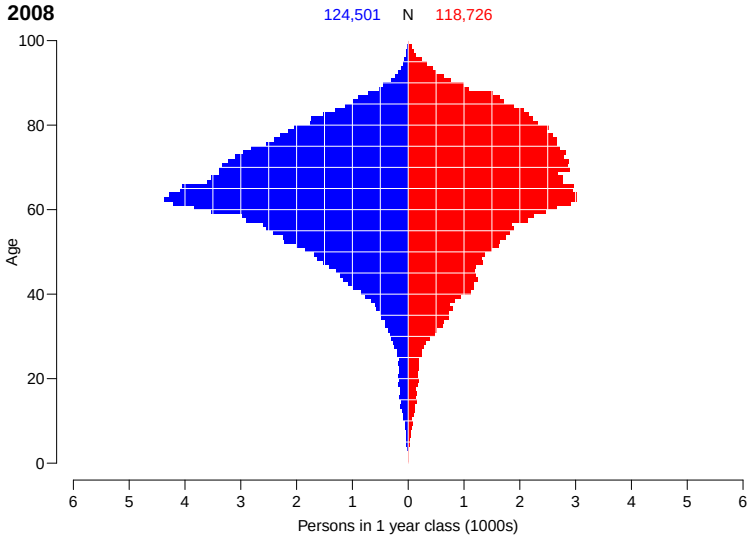

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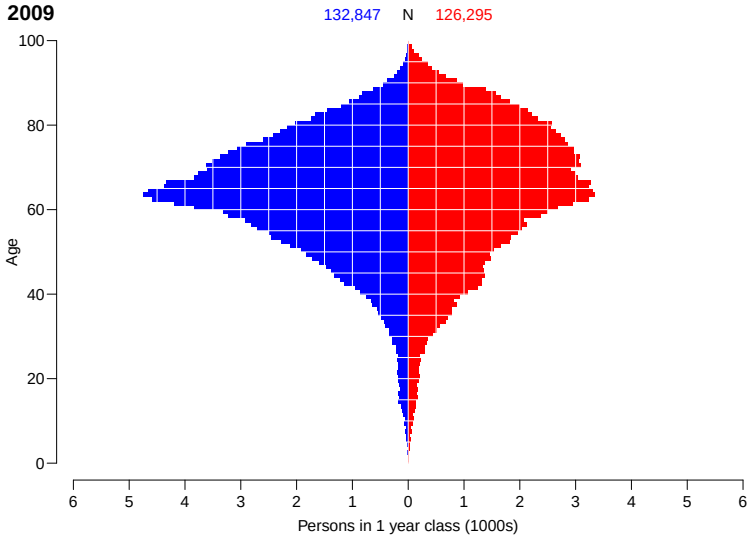

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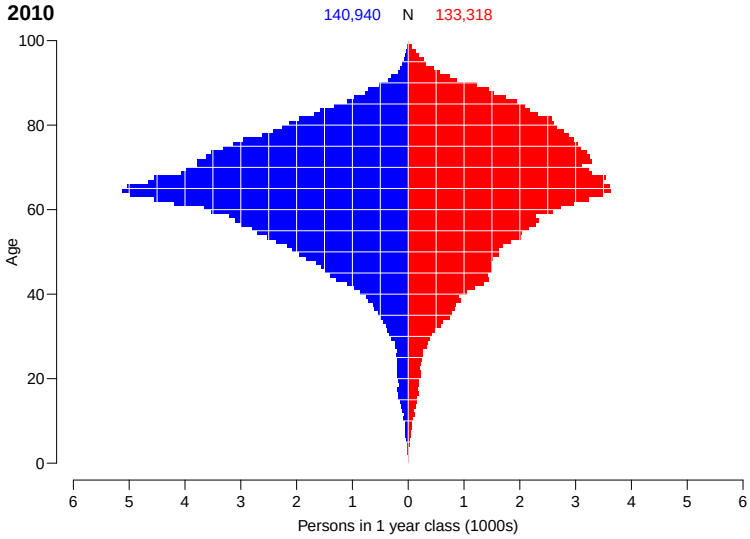

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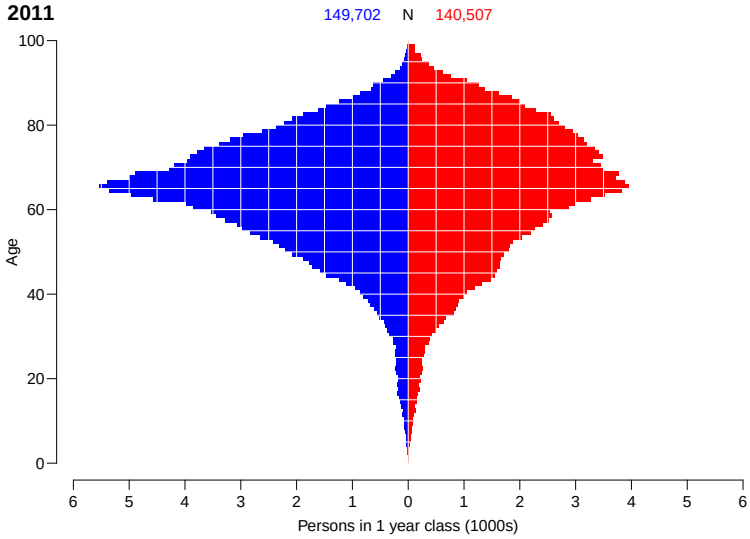

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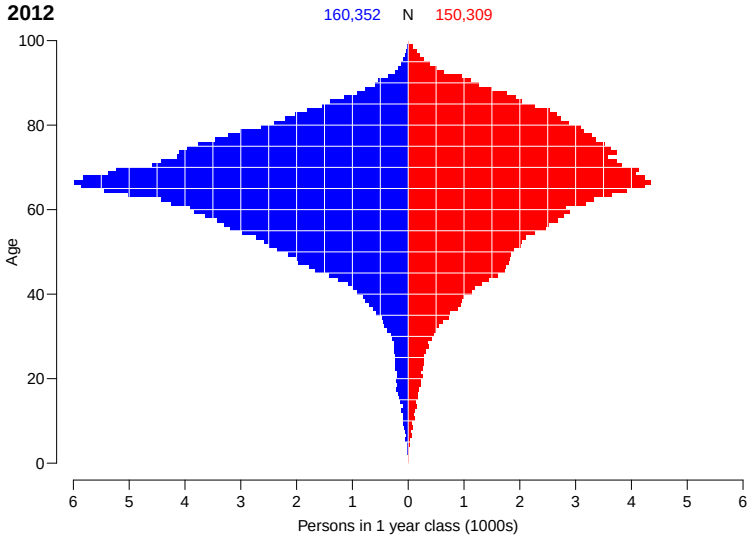
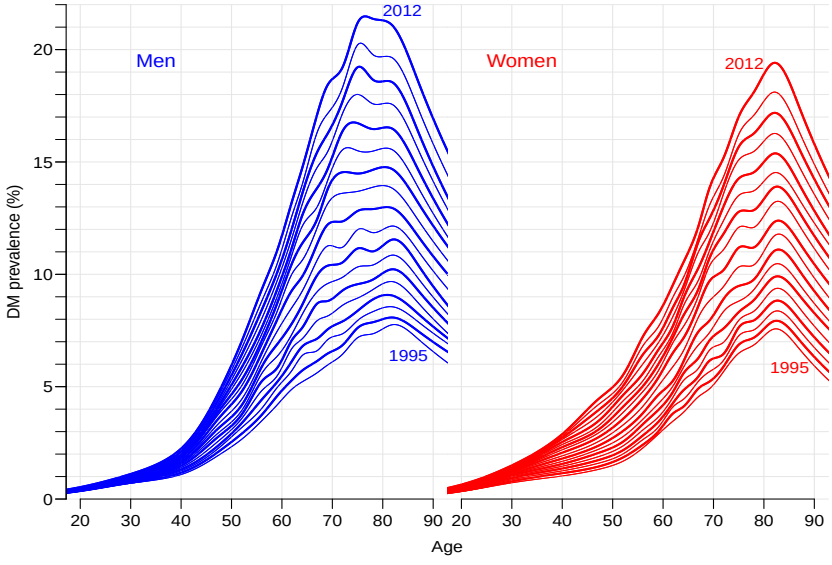


Prevalence of diabetes — % by age



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Number of deaths — imbalance

Year	New cases	Deaths	Surplus
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1996	15,385	7,147	8,238
1997	15,438	7,366	8,072
1998	16,842	7,457	9,385
1999	17,853	8,058	9,795
2000	18,480	8,242	10,238
2001	19,675	8,521	11,154
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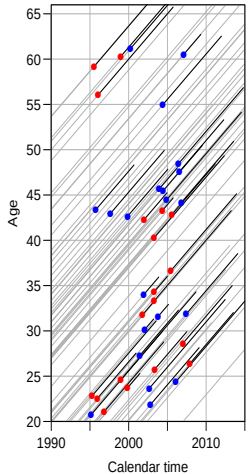
Incident cases



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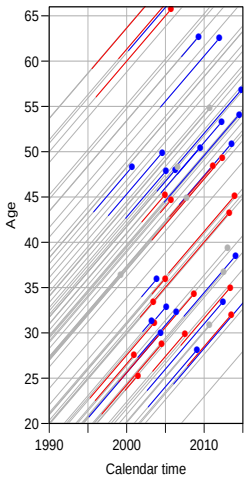
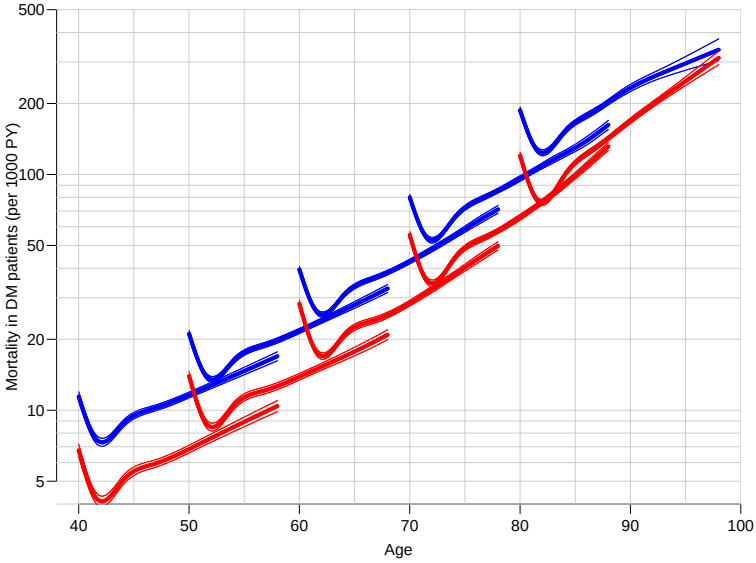
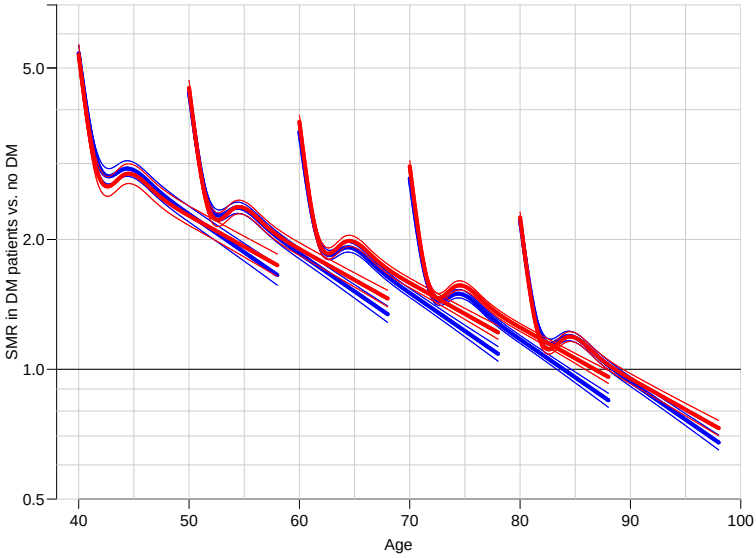


Mortality among DM patients



SMR relative to persons without DM



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A side effect of a project at Statistics Denmark

Only available inside the project, though.

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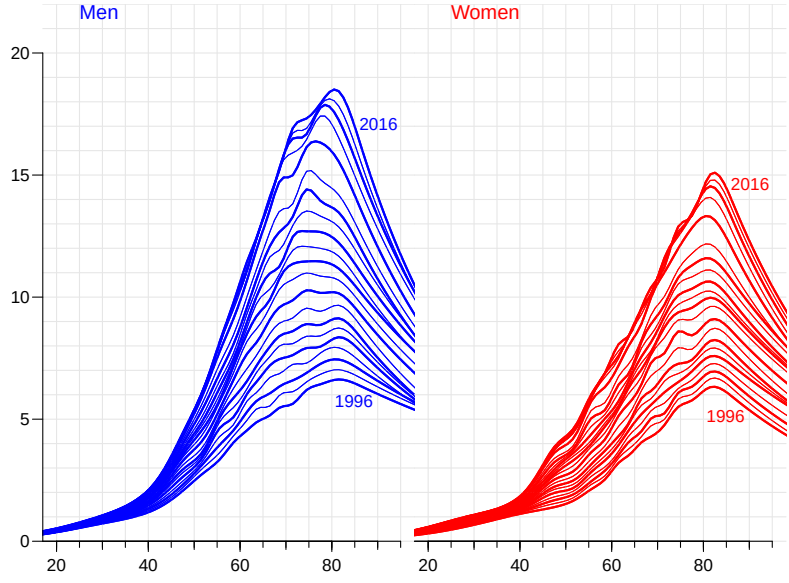
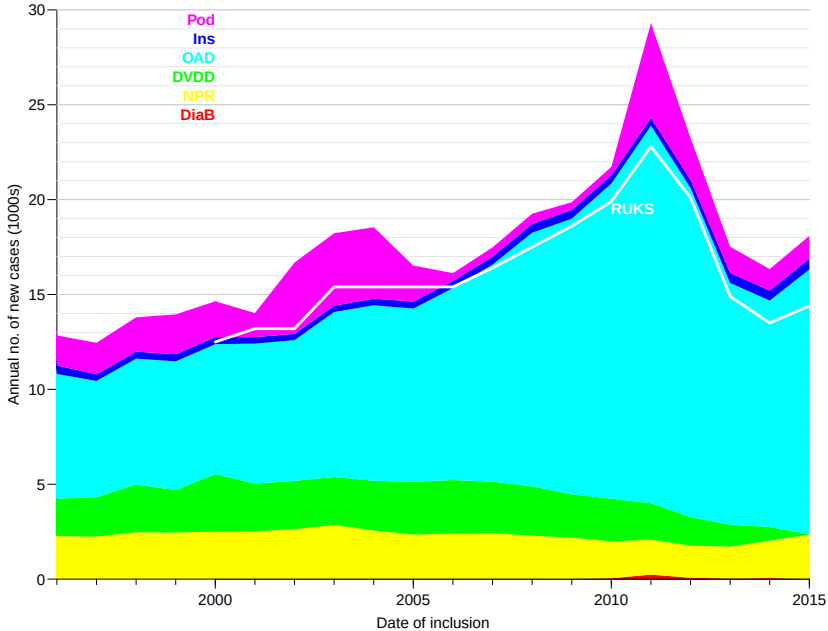
Age-specific prevalences of DM according to the reconstructed register.



Annual number of cases by the reconstructed algorithm, according to first criterion met.
White line is the RUKS annual number included



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  - duration of diabetes
  - duration of insulin use
- for all types of cancer
- and for specific sites of cancer

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ARTICLE

Cancer occurrence in Danish diabetic patients: duration and insulin effects

B. Carstensen · D. R. Witte · S. Friis

Received: 5 April 2011 / Accepted: 31 October 2011 / Published online: 27 November 2011

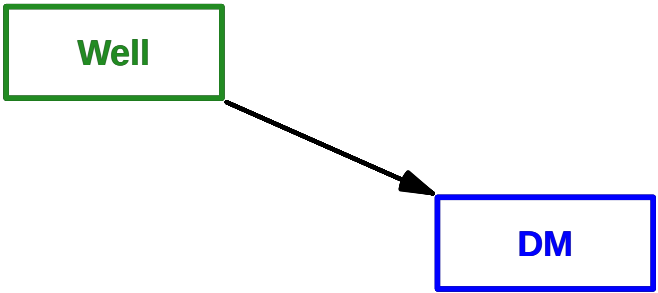
Abstract
Aims/hypothesis Cancer is more frequent among diabetes

population decreased from over 2 at diagnosis to 1.15 after 2 years of diabetes duration. The cancer incidence rate ratio

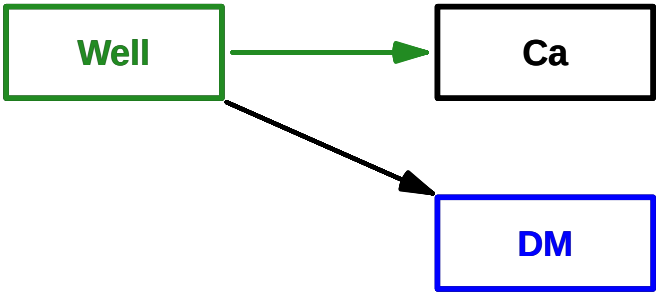
Follow-up of the Danish population

Well

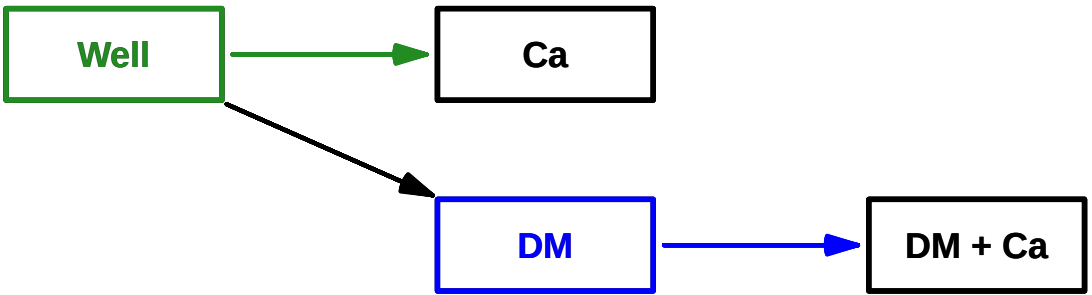
Follow-up of the Danish population



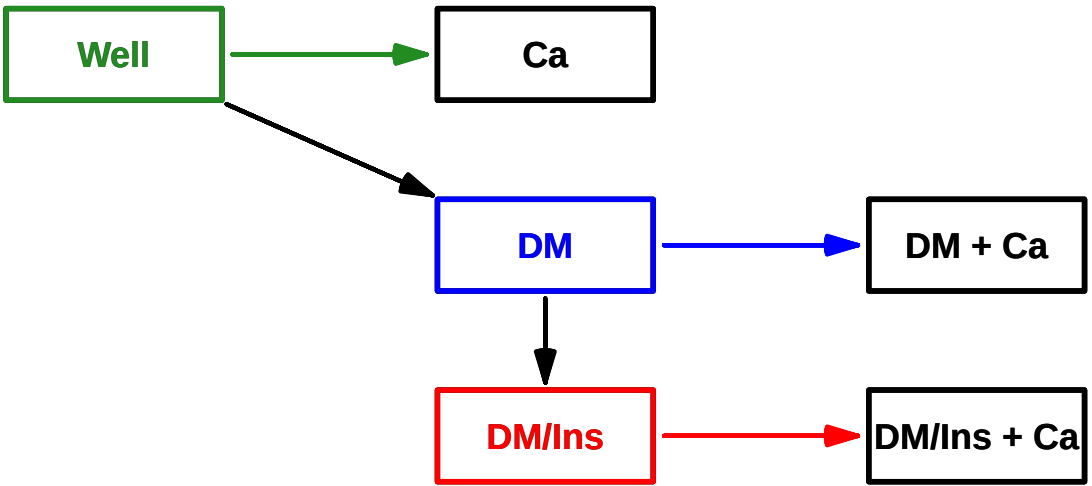
Follow-up of the Danish population



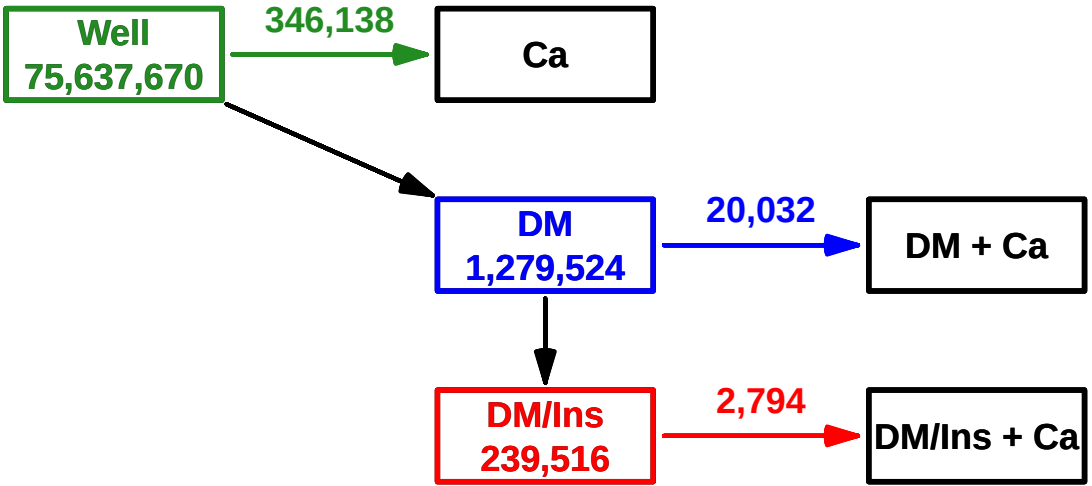
Follow-up of the Danish population



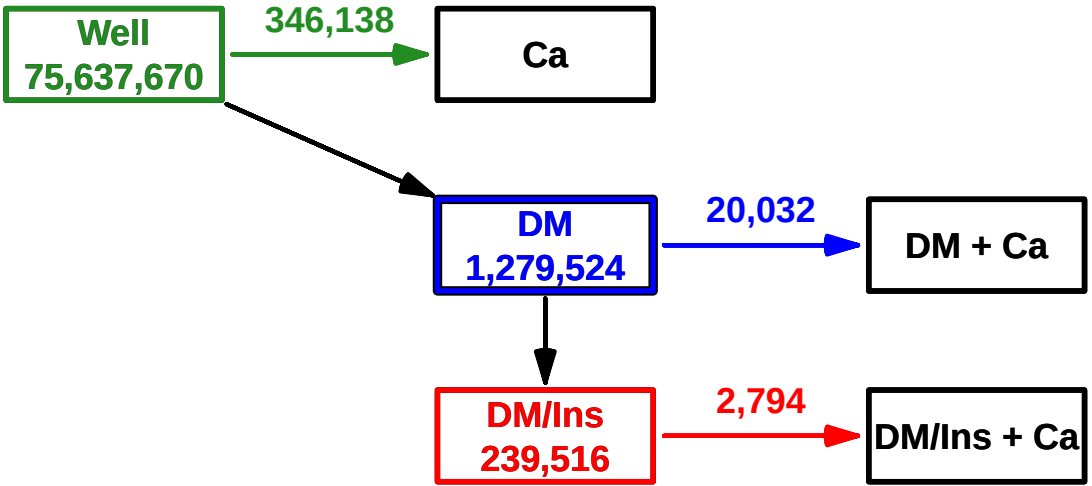
Follow-up of the Danish population



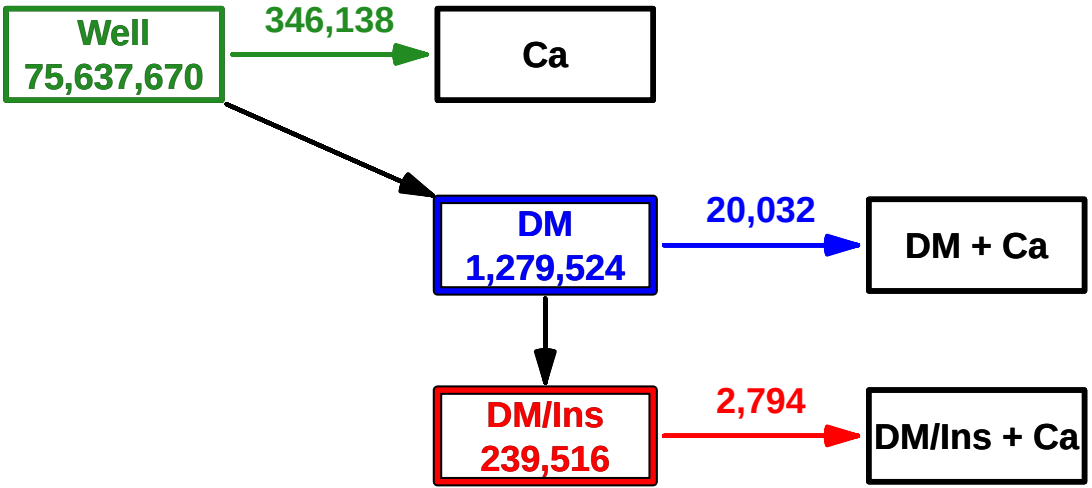
Follow-up of the Danish population



Follow-up of the Danish population



Follow-up of the Danish population



Follow-up in the population

Persons are followed 1 Jan 1995 to:

Follow-up in the population

Persons are followed 1 Jan 1995 to:

event: first primary cancer of a given type

Follow-up in the population

Persons are followed 1 Jan 1995 to:

event: first primary cancer of a given type

censoring:
- diagnosis of any other primary cancer

Follow-up in the population

Persons are followed 1 Jan 1995 to:

event: first primary cancer of a given type

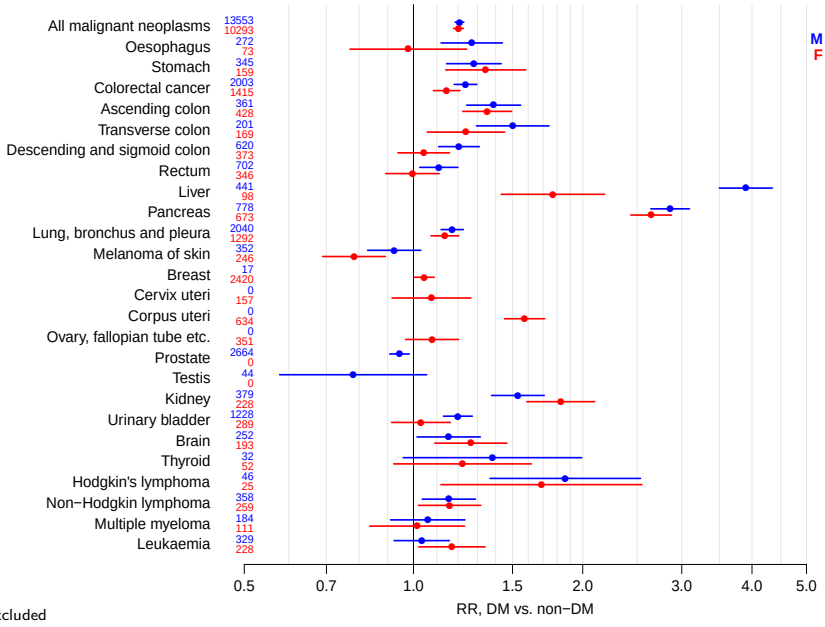
censoring:
- diagnosis of any other primary cancer
- death

Follow-up in the population

Persons are followed 1 Jan 1995 to:

event: first primary cancer of a given type

censoring:
- diagnosis of any other primary cancer
- death
- 31 Dec 2009



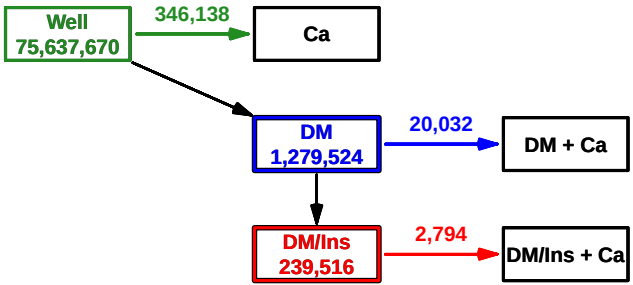
DM prevalent at 1.1.1995 excluded

Duration model

$$\text{rate} = f(\text{age}) \times g(\text{date of FU}) \times h(\text{date of birth})$$

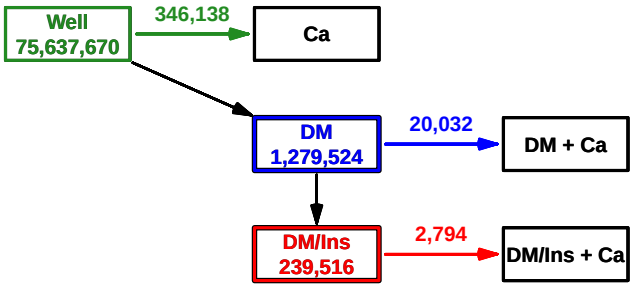
Duration model

$$\text{rate} = f(\text{age}) \times g(\text{date of FU}) \times h(\text{date of birth})$$



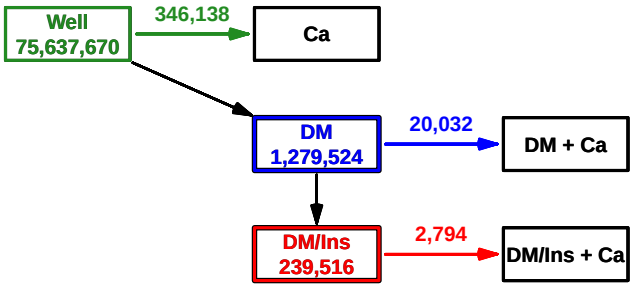
Duration model

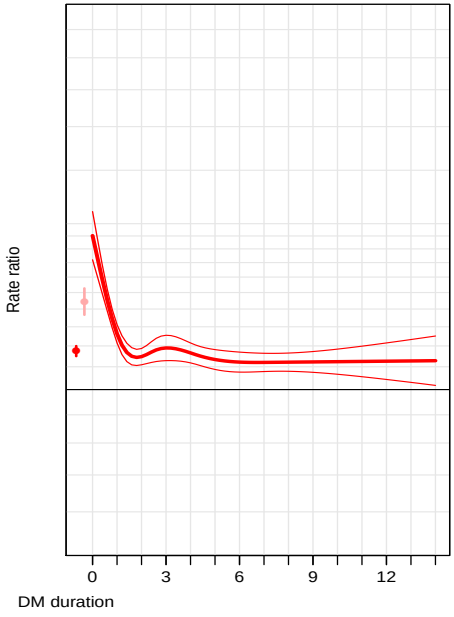
$$\text{rate} = f(\text{age}) \times g(\text{date of FU}) \times h(\text{date of birth}) \times t(\text{DM-duration})$$

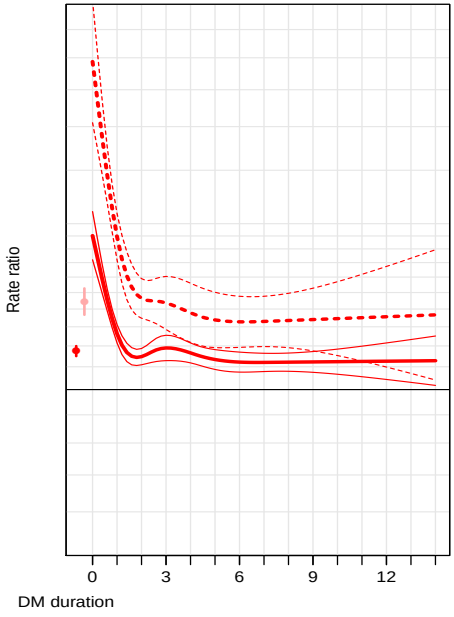


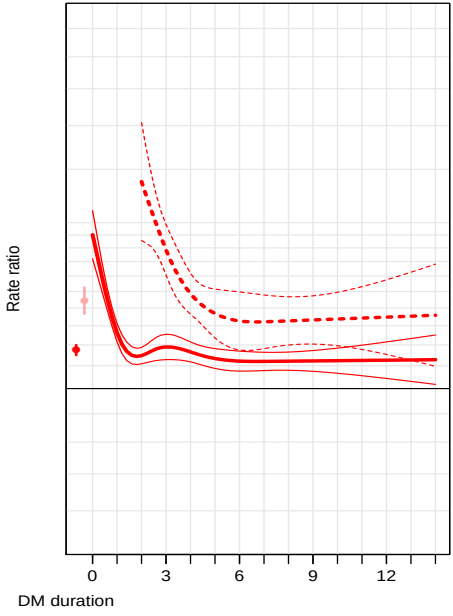
Duration model

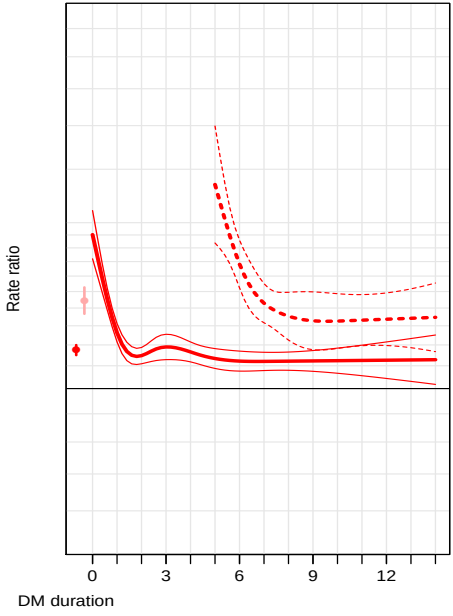
$$\begin{aligned}\text{rate} = & f(\text{age}) \times g(\text{date of FU}) \times h(\text{date of birth}) \\ & \times t(\text{DM-duration}) \\ & \times s(\text{Ins-duration})\end{aligned}$$

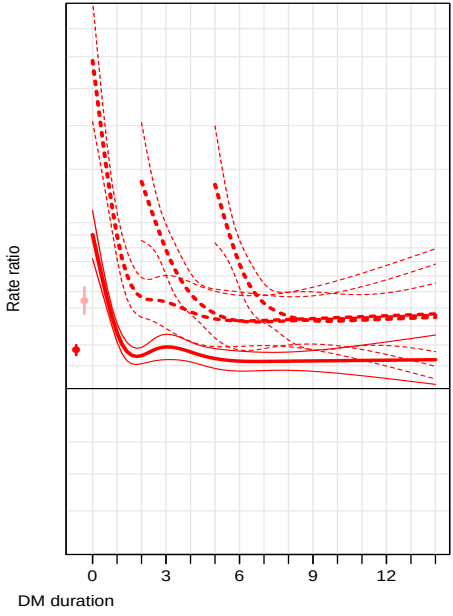


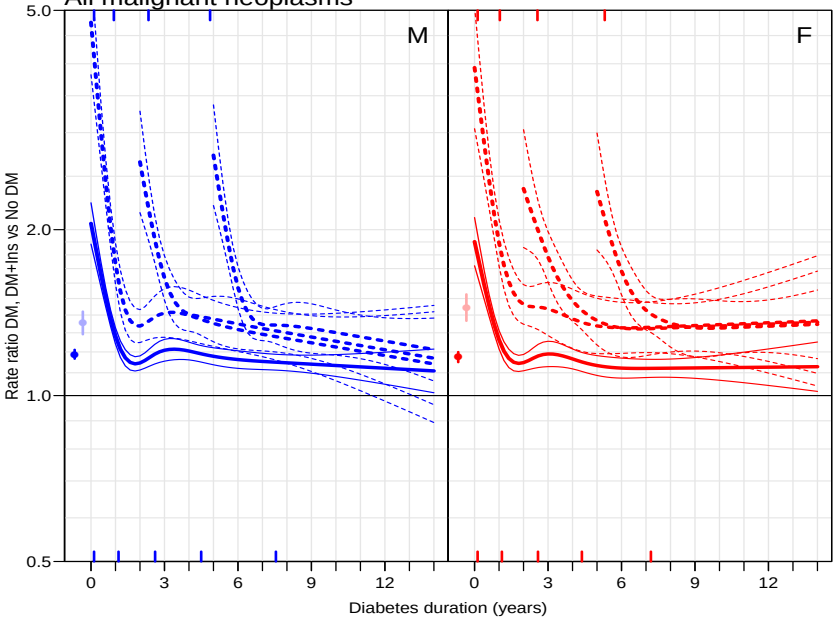

Rate ratio
0
3
6
9
12
DM duration

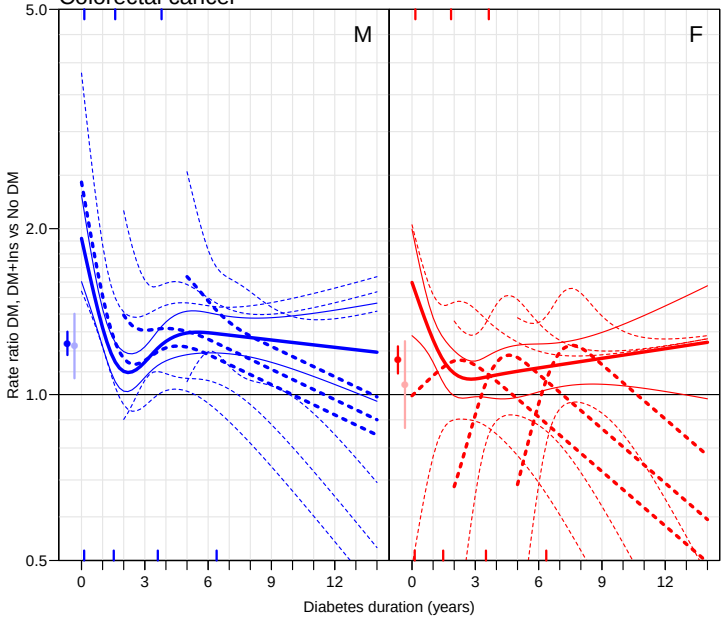

Rate ratio
0
3
6
9
12
DM duration

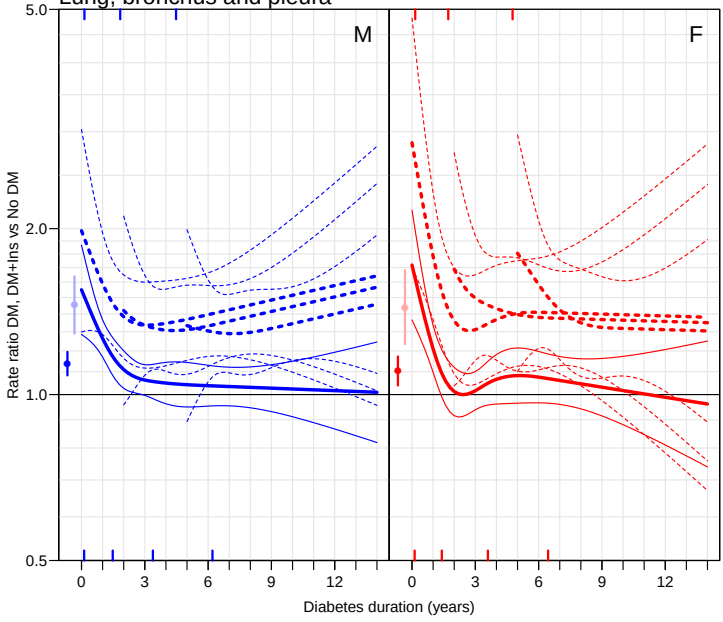

Rate ratio
0
3
6
9
12
DM duration

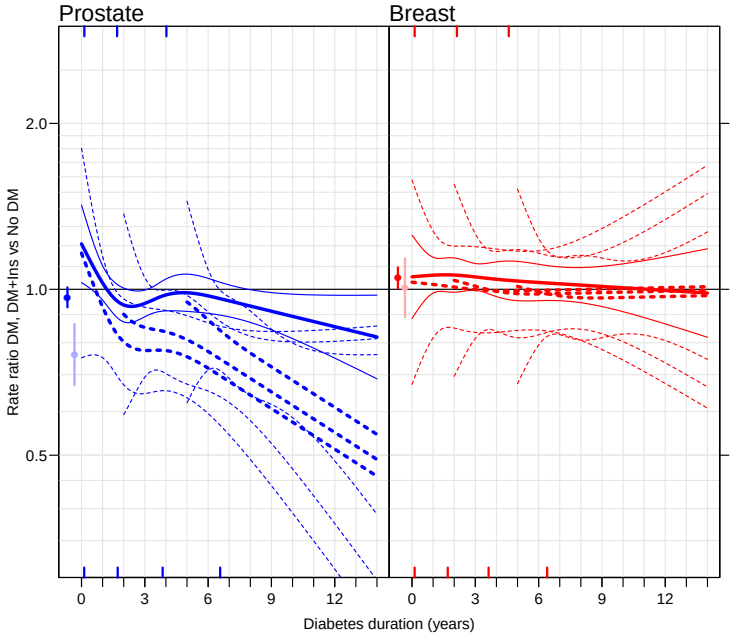

Rate ratio
0
3
6
9
12
DM duration


Rate ratio
0
3
6
9
12
DM duration


All malignant neoplasms
M
F
Rate ratio DM, DM+Ins vs No DM
5.0
2.0
1.0
0.5
0
3
6
9
12
Diabetes duration (years)


Colorectal cancer
M
F
Rate ratio DM, DM+Ins vs No DM
5.0
2.0
1.0
0.5
0
3
6
9
12
Diabetes duration (years)


Lung, bronchus and pleura
M
F
5.0
2.0
1.0
0.5
Rate ratio DM, DM+Ins vs No DM
0
3
6
9
12
Diabetes duration (years)


Prostate
Breast
Rate ratio DM, DM+Ins vs No DM
2.0
1.0
0.5
0
3
6
9
12
Diabetes duration (years)

Curr Diab Rep (2014) 14:535
DOI 10.1007/s11892-014-0535-8

DIABETES AND OTHER DISEASES-EMERGING ASSOCIATIONS (JJ NOLAN, SECTION EDITOR)

The Epidemiology of Diabetes and Cancer

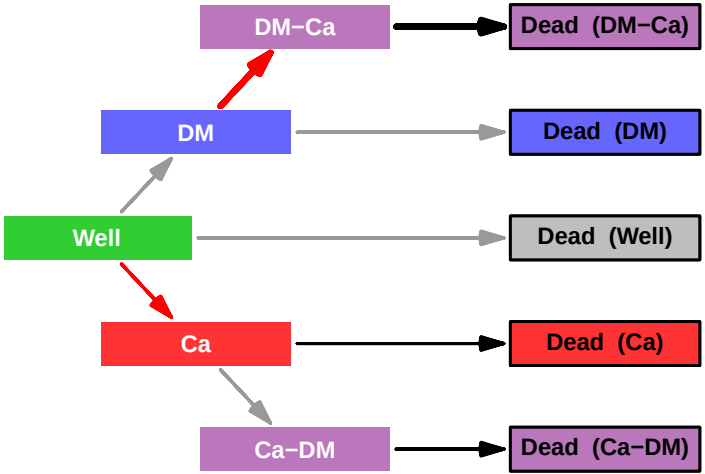
Bendix Carstensen · Marit Eika Jørgensen · Søren Friis

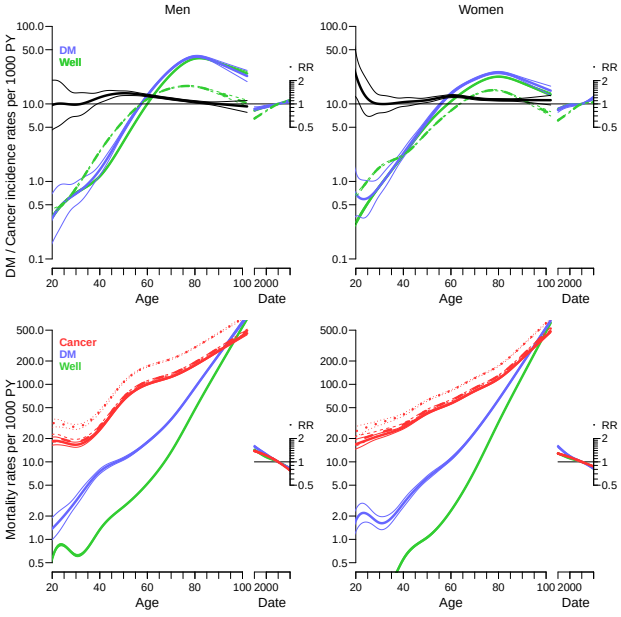
Abstract The literature on cancer occurrence in persons with diabetes has almost invariably been concerned with relative measures. In this paper, we briefly review this, but the aim is to quantify the absolute occurrence of diabetes and cancer in the population in order to give a fuller picture, which also

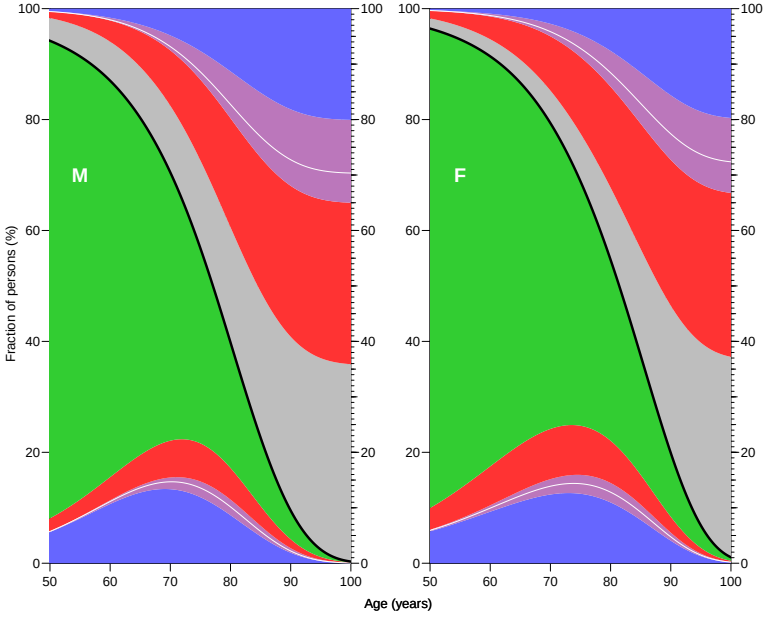
Introduction

The link between diabetes and cancer occurrence is well established, and comprehensive population-based studies have demonstrated that the association relates to both cancer

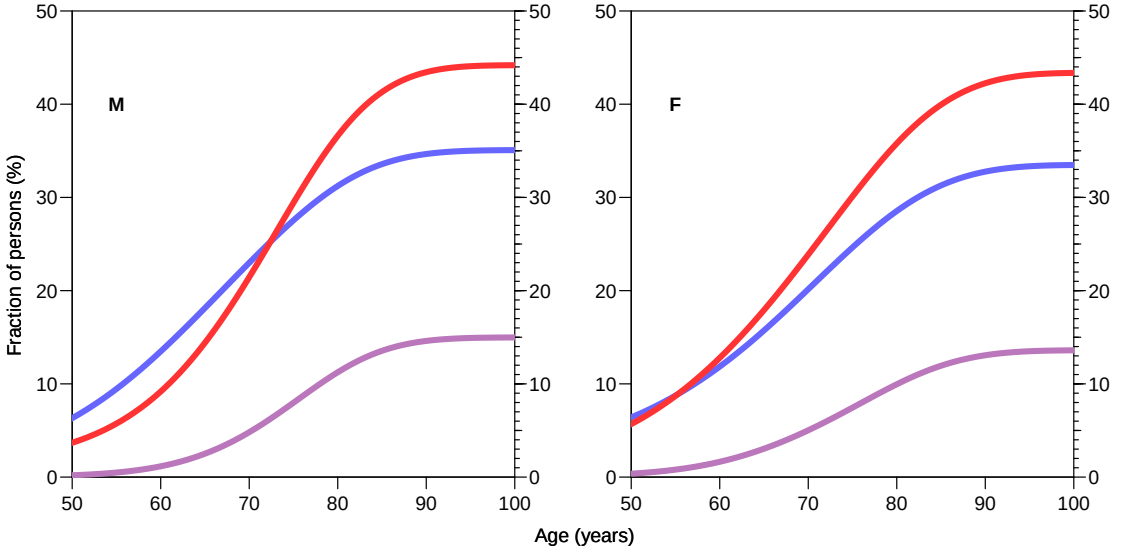
Demography: Life time risk

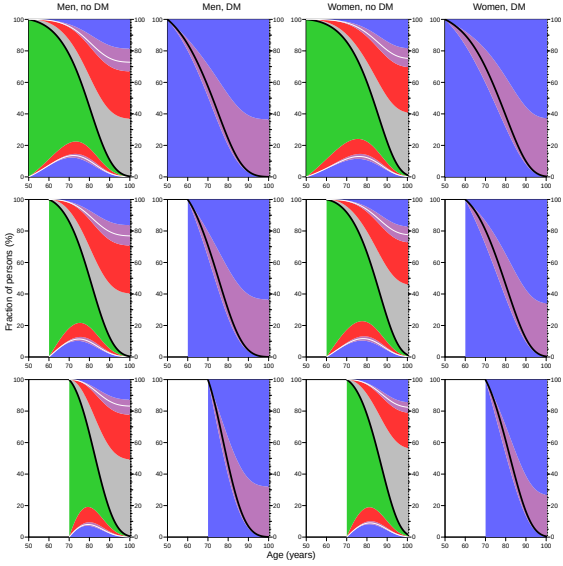



Men
Women
DM
Well
DM / Cancer incidence rates per 1000 PY
Mortality rates per 1000 PY
Cancer
RR
Age
Date


M
F
Fraction of persons (%)
Age (years)
0
20
40
60
80
100
50
60
70
80
90
100

Demography: Cumulative risk




Men, no DM
Men, DM
Women, no DM
Women, DM
Fraction of persons (%)
Age (years)