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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: Magliano D J, Chen L, Islam R M, et al. Trends in the incidence of diagnosed diabetes: a multicountry analysis of aggregate data from 22 million diagnoses in high-income and middle-income settings. *Lancet Diabetes Endocrinol* 2021; published online Feb 19. https://doi.org/10.1016/S2213-8587(20)30402-2.

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1 Protocol: Global and country-specific rates and trends in incidence of diagnosed total or type 2 diabetes

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1.1 Background

Over the past 30 years, the prevalence of diabetes in developed and developing countries has risen dramatically, making diabetes a key health priority globally. The rising prevalence of diabetes is often interpreted meaning that more people are developing diabetes, and that interventions to prevent diabetes are failing. However, increasing prevalence may also be due to improved survival of people with diabetes, because this increases the length of time that each individual remains within the population.

As treatment of diabetes improves and mortality falls, prevalence therefore becomes an unreliable marker of population change. Only incidence can measure the risk for the population, as well as indicate the success or otherwise of population-level prevention initiatives. Unfortunately, accurate and up-to-date diabetes incidence data are rare. This is because the standard longitudinal cohort studies, that have been the main source of incidence data, are unable to provide regular annual incidence estimates. However, the availability of large registry and administrative databases is starting to change this, and provides a means of analysing trends in diabetes incidence.

We have established an international collaboration which is the first global systematic approach to ascertain whether the incidence of type 2 diabetes is falling, stabilising or increasing. We will also explore mortality trends in diabetes. We will also explore whether trends in measured diabetes incidence are real or are due to changes in screening and detection of diabetes.

1.2 Hypothesis

- Diabetes incidence is starting to fall or plateau in some regions of the world.
- Decrease in the incidence of diagnosed diabetes is not due to changing screening practices.
- The decrease in diabetes incidence will be paralleled or preceded by a decrease in obesity prevalence and changes in other risk factors.
- Mortality in persons with diabetes is decreasing in both high and middle-income countries.

1.3 Aims

The principal aim of this project are to understand trends of the incidence and mortality of type 2 diabetes in adults in multiple sites around the world.

1.3.1 Specific aims:

Aim 1: to assess country-specific rates and trends from 1995 onwards in incidence and mortality of diagnosed type 2 diabetes in adults, in both high and middle-income countries, and to quantify the relative contribution of changes in mortality and incidence on the observed prevalence.

Aim 2: to understand whether the observed changes in incidence are due to changes in detection and screening of diabetes or to changes in true incidence. More specifically, the aim is to examine the relationship of screening rates (e.g. number of glucose or HbA1c tests per unit time) and differential use of various diagnostic tests to the observed diabetes incidence rates.

This second aim will only be conducted on a limited set of data sources (see below).

1.4 Research Plan

1.4.1 Infrastructure

To facilitate this study, a partnership has been established between the Diabetes and Population Health group at Baker Heart and Diabetes Institute and the Centers for Disease Control and Prevention in Atlanta to conduct this study.

1.4.2 Data sources:

We aimed to identify all data sources that could potentially report the number of incident cases year by year for at least three years within the years 1995 onwards, from a general population, from an insurance or claims population or from a multi-site clinical population, which is predominantly primary care. The most likely sources are diabetes registries, health insurance providers, health maintenance organizations and collections of electronic medical records. To contribute fully to the project, data sources need to stratify data by age and sex, and to also have accurate information about the numbers of people in the background population (the denominator), about deaths, and about prevalent diabetes. Those sources lacking this additional information will be included, but will not be able to contribute to the main analysis (if lacking denominator information) or to secondary analyses (when lacking other data). An alternative source is a series of high-quality, cross-sectional, population-based surveys in which information on diabetes duration has been collected.

Data sources were identified by two methods. First, a systematic review of all publications on diabetes incidence searched in 2016 was used to identify all published studies from data sources with the potential to contribute to the project. Second, the clinical and research networks of the investigators were used to identify potential data sources. Contact was then made with relevant investigators or administrators to determine both interest and capacity to participate.

1.4.3 Data extraction and definitions for Aim 1

Each data source will be requested to provide tabular, summary data, with counts of incident and prevalent diabetes cases, deaths and the background population. No unit record data will be requested. Data extraction and specific definitions will vary among the

data sources. This is at least in part because of issues that are necessarily specific to countries and data sources. Nevertheless, the following definitions and guidelines should apply wherever possible, and exceptions should be noted

1. Diabetes comprises type 1 (including latent autoimmune diabetes of adults – LADA) and type 2 diabetes, but not gestational diabetes. Where gestational diabetes cannot be differentiated from other types, data in women of reproductive age (likely <50 or <45 years old) will be excluded from analyses, but should still be provided in initial data extractions. People with other forms of diabetes should not be excluded, because of the rarity of these forms, and the inconsistency of diagnostic coding for such forms among data sources.

2. Diabetes type (i.e. type 1 or type 2) will be assigned where adequate information is available. Ideally, this is based on an algorithm considering age of diagnosis and time to insulin therapy, in which age of onset <30 years and time to insulin therapy <1 year are indicative of having type 1 diabetes. Clinical assignment of diabetes type is also acceptable.

3. Diabetes will be ascertained and defined on the basis of a diagnosis or diagnostic code provided by a relevant healthcare professional, or at least two of:

   (a) the presence of two or more blood glucose or HbA1c values within the diagnostic ranges for diabetes (fasting plasma glucose $\geq$ 7.0 mmol/l (126 mg/dl), random or 2-hour plasma glucose $\geq$ 11.1 mmol/l (200 mg/dl) or HbA1c $\geq$ 6.5% (48 mmol/mol)), within a 6-month period;

   (b) prescription of glucose-lowering medication for at least 3 months;

   (c) the provision of a service that is unique to people with diabetes.

4. For health survey data sources, diabetes status is based on self-report of the participant.

5. An incident case of diabetes for a particular year is defined as a person who, between 1 January and 31 December of that year, is either:

   (a) a new case in a diabetes register, and was not on the register in the previous year; or

   (b) newly diagnosed in a medical record or claims database, and was registered in the medical record or claims database for the previous 12 months and was not identified as having diabetes during that time.

6. The date of diagnosis of an incident case is the date on which the earliest diagnostic criterion (listed in (3) above) is satisfied. Thus, a person whose first criterion is satisfied in one year, and their second criterion is satisfied the next year is deemed to be an incident case in the first year.

7. Individuals with a date of diagnosis of diabetes earlier than their date of registration with the database (e.g. a person with established diabetes joining an HMO or medical practice) should not be included as an incident case (to comply with 3b),

when the medical record or a claims database is the direct source of information (which may also be the case for virtual registers). This does not generally apply to stand-alone registries, in which such cases can be included, unless such cases are likely to be new immigrants. When such cases are included, it is assumed that they are represented in the population counts of the denominator in the years of and preceding their year of diagnosis. Their year of diagnosis, rather than year of registration, should usually be taken as the year in which they became an incident case.

8. A prevalent case of diabetes in any given year is someone who has diabetes, as established by the above criteria, on January 1 that year. Incident cases are not considered as prevalent cases in the calendar year in which they became an incident case.

9. Death will be ascertained either from national death registers or from death data held in the database being used.

10. The denominator for each year and each age-group is the number of people without clinically diagnosed diabetes on 1 January of each year in the population from which the incident cases are drawn – this might be the national or regional population (deriving from census data), or the population in the electronic medical record or claims database. Where possible, person-years are preferred to simple counts, in order to fully account for the precise amount time an individual spends in each state.

1.4.4 Data extraction for Aim 2

Data for this aim will be obtained from only a subset of centres where the relevant data are available. This data will include the number of diagnostic tests over time. Eg: the number of fasting glucose tests, 2 hour glucose tests or HbA1c tests completed each month by sex over each year where incidence is measured. We will then be able to examine the number of new cases of diabetes per diagnostic test over time and determine whether screening practices influences incidence trends.

1.4.5 Analysis Plan

Aim 1: *to assess country-specific rates and trends in incidence of diagnosed type 2 diabetes, and trends in mortality of persons with diabetes in both high and middle-income countries.*

For this aim, we will use data from all available data sources. All analyses will be conducted separately for men and women. We will analyse diabetes incidence rates by age and calendar year to determine trends over calendar time and compare these across data sources. Specifically we will fit age-period, age-period-cohort and Lee-Carter models [2] for incidence counts using Poisson regression with person-years as denominators and provide smoothed time trends for each data source, enabling quantitative display of trends as well as formal comparison of trends between data sources. Moreover, the modeling approach will enable us to assess to what extent the changes in incidence rates unfold in the same manner at different ages. The same type of analyses will be undertaken for mortality rates among people with diabetes. Finally, we will use the estimated incidence and mortality for prediction of the observed prevalence under different scenarios and quantify the relative contribution of changes in mortality and incidence on the observed prevalence.

Data preparation will be performed in Australia in Excel Sheet (see Data Extraction Template in figure A0) and will be converted to a CSV containing all of the data will be sent to Denmark for analyses by Bendix Carstensen, Steno Diabetes Center Copenhagen. There is an additional document which asks some questions about the data source (see Attachment below).

Aim 2: *to examine the relationship between screening rates (eg number of glucose or HbA1c tests per unit time) and differential use of various diagnostic tests to observed diabetes incidence rates.*

We will take a direct approach to understand whether changes in incidence trends are real and not due to changes in screening practices. There are currently at least three data sources that allow the estimation of diagnostic screening rates. These include the Health Improvement Network (United Kingdom), the Maccabi Healthcare Services dataset (Israel) and Clalit Health Services (Israel) dataset. By examining the number of new cases of diabetes per diagnostic test over time, we can map whether screening practise influences incidence trends.

This analyses will be conducted in Melbourne, Australia in consultation with Bendix Carstensen, Steno Diabetes Center Copenhagen.

1.5 Publications and Disseminations

The results of this research will be published in peer-reviewed journals. Up to two authors will be included on each publication from each collaborating centre as well as the authors from this coordinating centre (Baker Heart and Diabetes Institute, Australia). Data obtained from each centre are aggregate data only.

1.6 Outcomes and Significance:

Since the current prevalence-based reports of diabetes have significant limitations in providing the relevant insights, the successful completion of this project will be a significant impetus to develop the reporting of incidence as a key measure of the changing global burden of diabetes. It will provide vital data for policy on diabetes worldwide, provide information to understand patterns of incidence and mortality, and help us understand whether our interventions have worked and highlight potential 'hotspots' for diabetes incidence now and in the future.

1.7 Attachment: Data source description

Please answer the questions below, so that we have an accurate description of each of the data sources used for this project. These answers are very important in order to fully understand any biases that may exist. If you have previously provided us with all or some of this information, there is no need to repeat it here.

1. Please provide the name and description (e.g. national register, insurance).

2. Please describe the nature of the population that the people with diabetes come from (e.g. national population, people in employment, people choosing to have insurance, geographic restrictions).

3. Please indicate if, within the geographic area that that the data source serves, there are groups of people who are systematically missed from the data source (e.g. uninsured, insured with a different insurer, users of private health care).

4. Please give a description of how diabetes is defined (e.g. diagnostic code, use of glucose-lowering drugs, blood glucose/HbA1c, or combination of fields).

5. Please explain what criteria are used to determine diabetes type (i.e. T1DM and T2DM).

6. Please explain if and how you have excluded or identified gestational diabetes

7. Please explain how you derive the number of deaths (mortality counts) in your database?

8. What year did the database begin?

9. Please estimate the percentage (or percentage range) of completeness of the capture of diabetes cases. If this differs between type 1 and type 2 diabetes, please provide two estimates.

10. Have you conducted any studies to assess the completeness of diabetes capture? If so, can you please provide the reference or the document?

11. Other relevant information about the database, if any.

Name of data							
Diabetes data:	Type 2						
	1995						
	No. of new cases of type 2 diabetes (New cases from 1 Jan-31 Dec)	**No. of deaths in type 2 diabetes** (1 Jan-31 Dec)	**No. of prevalent cases of type 2 diabetes** (As of 1 Jan that year - do not include incident cases occurring in that year, only person with type 2 diabetes alive at 1 Jan)	**Population number as of Jan 1** (This would include prevalent type 2 diabetes)	**No. of deaths in the total population in the database** (1 Jan-31 Dec)	**Person years in type 2 diabetes** (This will be used for mortality rates in type 2 diabetes)	**Person years in those without type 2 diabetes**
Males							
mean age							
Age groups							
<20							
20-24							
25-29							
30-34							
35-39							
40-44							
45-49							
50-54							
55-59							
60-64							
65-69							
70-74							
75-79							
80-84							
>=85							
All males							
Females							
Mean age							
Age groups							
<20							
20-24							
25-29							
30-34							
35-39							
40-44							
45-49							
50-54							
55-59							
60-64							
65-69							
70-74							
75-79							
80-84							
>=85							
All females							

Figure A0: *Data extraction template. This is an example of data extraction required for type 2 diabetes for a single year of 1995.*

2 Data definitions and data quality

2.1 Diabetes definitions

The table A1 details the definitions of diabetes that were used in each country / region / study.

Table A1: *Diabetes definitions by data source*

Country / region	Diagnostic method	T1, T2 separated	GDM excluded
Australia	Clinical diagnosis certified by a doctor, nurse or credentialed diabetes educator.	Yes	Yes
Canada	Algorithm incorporating ≥ 1 hospitalisations or ≥ 2 physician claims with evidence of diabetes within 2 years.	No	Yes
Denmark	Algorithm incorporating clinical diagnosis (ICD codes) from the hospitalisations or outpatient clinics, prescription of anti-diabetic medications, clinical and billing records.	Yes	Yes
France	Defined by use of anti-diabetic medications.	No	No
Hong Kong	Algorithm incorporating use of diagnostic or procedure codes (ICD-9) for all hospital admissions, diagnostic codes based on ICPC-2 WONCA (for general outpatient clinics), prescription of anti-diabetic medications and laboratory tests.	No	Yes
Hungary	Defined by use of anti-diabetic medications.	Yes[c]	Yes
Israel, Cl[a]	Algorithm incorporating annual diabetes diagnosis from hospital and community medical records, lab tests and prescription of anti-diabetic medications.	No	Yes
Israel, Mc[b]	Algorithm incorporating blood tests, prescription of anti-diabetic medications and clinical diagnosis by clinical practitioners.	Yes	Yes
Italy, Lombardy	Algorithm incorporating certified diagnosis from disease-specific registry, prescription of anti-diabetic medication according to ATC code A10, diagnosis-related group code of hospitalisation for diabetes.	No	No
Korea(South)	Defined by use of anti-diabetic medications.	No	No

Table continues next page

Table A1: *(cont'd): Diabetes definitions by data source.*

Country / region	Diagnostic method	T1, T2 separated	GDM excluded
Latvia	Clinical diagnosis using ICD-10 codes.	Yes	Yes
Lithuania	Clinical diagnosis using ICD-10 codes.	No	Yes
Netherlands	Clinical diagnosis by ICPC codes.	No	No
Norway	Clinical diagnosis by ICD-10 and ICPC-2 codes.	Yes[c]	No
Russia	Algorithm incorporating clinical diagnosis, blood glucose tests and prescription of anti-diabetic medications.	Yes	Yes
Scotland	Clinical diagnosis using the Read coding system.	Yes	No
Singapore	Clinical diagnosis using ICD-10 codes.	No	No
Spain	Clinical diagnosis using ICD-10 codes.	Yes	Yes
Taiwan	Algorithm incorporating a hospital discharge code of diabetes, ≥ 2 diagnosis codes of diabetes from the outpatient clinics within one year, and prescription of anti-diabetic medications.	Yes[c]	Yes[d]
UK	Clinical diagnosis using the Read coding system.	Yes	Yes
Ukraine	Clinical diagnosis.	Yes	Yes
US, KPNW[e]	Algorithm incorporating hospitalisation with diabetes as primary discharge diagnosis, ≥ 2 out-patient visits, anti-diabetic medications or two abnormal blood results from an integrated healthcare delivery system.	Yes	Yes
US, Medicare	Algorithm incorporating claims for hospital inpatient and outpatient, physician/provider services, home health agency, and skilled nursing facility services.	No	Yes
US, NHIS[f]	Self-report from a series of cross sectional studies.	No	Yes

[a] Clalit Health Service. [b] Maccabi Healthcare Service. [c] Type 2 only.
[d] Prior gestational diabetes that later was diagnosed with T2D was not excluded.
[e] Kaiser Permanente Northwest. [f] National Health Interview Survey

Table A2: *Contributed diabetes events and person-years and period covered (calendar years) from each data source*

	Incident diabetes		PY (1000s)		Years covered	
	Men	Women	Men	Women	First	Last
Australia	481,309	378,295	143,120	143,699	2002	2015
Canada	1,630,800	1,404,640	240,780	248,352	2000	2015
Denmark	193,518	157,609	54,843	56,162	1996	2016
France	827,979	680,830	177,427	191,202	2012	2017
HongKong	262,119	235,517	37,357	42,385	2005	2016
Hungary	143,711	151,821	35,075	38,350	2009	2016
Israel(CHS)	179,009	178,216	25,015	26,281	2004	2016
Israel(MHS)	61,986	52,187	12,371	13,177	2001	2015
Italy	316,235	302,656	47,369	50,582	2002	2012
Korea(South)	27,949	22,566	4,578	4,628	2006	2015
Latvia	43,567	77,186	17,680	20,572	1999	2016
Lithuania	46,392	61,887	19,752	22,727	2003	2016
Netherlands	17,492	14,992	3,601	3,705	2011	2016
Norway	55,116	42,209	15,027	14,944	2009	2014
Russia	1,498,731	3,342,897	1,274,029	1,463,284	2000	2018
Scotland	119,970	94,578	28,910	31,210	2004	2015
Singapore	66,910	59,455	8,821	9,157	2012	2016
Spain	142,959	108,028	26,235	27,091	2007	2016
Taiwan	31,264	27,069	4,510	4,335	2002	2011
UK	113,942	91,556	54,686	59,170	2000	2013
Ukraine	4,046	6,457	2,853	3,204	2005	2010
USA(KPNW)	27,731	26,339	4,592	4,887	1995	2016
USA(Medicare)	3,607,142	4,599,771	92,108	138,744	2001	2015
USA(NHIS)	2,448	3,224	236	298	1995	2015
Sum	9,902,325	12,119,985	2,330,976	2,618,144		

2.2 Quality score algorithm

We used a modified Newcastle-Ottawa Quality Assessment Scale.

The scale includes items that assess representativeness of the data sources, sample size at each time point, the method of defining diabetes, whether people with gestational diabetes were excluded, and completeness of the number of data points reported. The maximum score was 8 and total scores were defined as high (7–8), medium (5–6), or low (≤ 4). A study can be awarded a maximum of one, two or three points for each numbered item within each category.

Selection

1. Representativeness of the general population (sampling frame).
   (a) National scheme with $\geq 80\%$ coverage of national population (2 points)
   (b) Random sample from national health insurance (1 point) or national population-based survey with $\geq 80\%$ response rate
   (c) Regional representative or national scheme with $\leq 80\%$ coverage of national population (0 points)
2. Sample size at each time point.
   (a) $\geq 10,000$ (1 point)
   (b) $\leq 10,000$ (0 points)

Outcome

1. Assessment of diabetes status.
   (a) By blood glucose measurement (FPG, OGTT, HbA_{1c}) or by multiple approaches/ administrative algorithm where 2 or more criteria used (2 points)
   (b) Clinical diagnosis (e.g. ICD code or physician-diagnosed) (1 point)
   (c) Anti-diabetic medication or self-report of physician-diagnosed diabetes (0 points)
2. Exclusion of gestational diabetes
   (a) Yes (1 point)
   (b) No (0 points)

Completeness of trend data

1. How many time points are provided?
   (a) ≥ 10 (2 points)
   (b) 6 – 9 (1 point)
   (c) ≤ 6 (0 points)

Thus the total possible score is 8.

2.3 Quality score assessment

The table A3, summarizes the data quality from the different sources used in the study.

Table A3: *Quality assessment of the included data sources.*

Country, Region	Origin of data	Representativeness of population	Sample size at time points	Assessment of diabetes	Exclusion of gestational diabetes	Completeness (no. of data points)	Total Score
Range of allocated points:		0–2	0–1	0–2	0–1	0–2	8
Australia	National Diabetes Services Scheme	2	1	1	1	2	7
Canada	Canadian Chronic Disease Surveillance System	2	1	2	1	2	8
Denmark	National administrative databases	2	1	2	1	2	8
France	National Health Data System	2	1	0	0	1	4
Hong Kong	Hong Kong Hospital Authority	2	1	2	1	2	8
Hungary	National Institute of Health Insurance Fund Management database	2	1	0	1	1	5
Israel(CHS)	Clalit Health Services (Insurance)	0	1	2	1	2	6
Israel(MHS)	Maccabi Health Care (Insurance)	0	1	2	1	2	6
Italy, Lombardy	Administrative health databases in Lombardy	0	1	2	0	2	5

Table continues next page

Table A3: *Quality assessment of the included data sources (cont'd).*

Country, Region	Origin of data	Representativeness of population	Sample size at time points	Assessment of diabetes	Exclusion of gestational diabetes	Completeness (no. of data points)	Total Score
Range of allocated points:		0–2	0–1	0–2	0–1	0–2	8
Korea(South)	National Health Insurance Service – National Sample cohort	1	1	0	0	2	4
Latvia	National diabetes registry	2	1	1	1	2	7
Lithuania	National Health Insurance information system "SVEIDRA"	2	1	1	1	1	6
Netherlands	NIVEL Primary Care Database	0	1	1	0	1	3
Norway	Norwegian Patient Registry, Primary Care Database and Norwegian Prescription Data Base	2	1	1	0	1	5
Russia	National Diabetes Register of Russian Federation	2	1	2	1	2	8
Scotland	Scottish Care Information-Diabetes (SCI-Diabetes) database	2	1	1	0	2	6
Singapore	National administrative data hold by the Ministry of Health of Singapore	2	1	1	0	0	4

Table continues next page

Table A3: *Quality assessment of the included data sources (cont'd).*

Country, Region	Origin of data	Representativeness of population	Sample size at time points	Assessment of diabetes	Exclusion of gestational diabetes	Completeness (no. of data points)	Total Score
Range of allocated points:		0–2	0–1	0–2	0–1	0–2	8
Spain	Information System for the Development of Research in Primary Care [SIDIAP]	0	1	1	1	2	5
Taiwan	National Health Insurance Research database	1	1	2	1	2	7
UK	The Health Improvement Network (THIN) database	0	1	1	1	2	5
Ukraine	System of Diabetes Mellitus Care in Ukraine (SINADIAB) in Volynska Oblast region	0	1	1	1	1	4
US(KPNW)	Kaiser Permanente Northwest health care delivery system	0	1	2	1	2	6
US(Medicare)	Medicare claims data for beneficiaries	2	1	2	1	2	8
US(NHIS)	National Health Interview Survey	1	0	0	1	2	4

3 Statistical analyses

Data were provided from each data source as number of diabetes cases and person-years classified by sex, single calendar year and 5-year age classes, < 20, 20–24, ..., 75–79, 80–84 and 85+; some data sources use 70+ as the upper age-class.

Age was used as a quantitative variable, `A` with values 12, 22.5, 27.5, ... 82.5, and 78 and 88 for the 70+ and 80+ age-classes. Calendar time was scored as a quantitative variable, `P` (period), with value 2010.5 for the calendar year 2010 etc., so in quantitative terms we refer to 1 January 2010 as 2010.0, 3 July 2010 as 2010.5 and 31 December 2010 as 2010.997. For each observational unit in data we thus have the mean age and date of follow up, and we defined the mean date of birth, `C` (cohort), as `P-A`.

3.1 Age-period-cohort modeling

We fitted age-period-cohort models (APC models) for the log-incidence rates (a and p refer to the variables `A` and `P` defined above):

$$\log\big(\lambda(a,p)\big) = f(a) + g(p) + h(p-a)$$

where the three effects were modeled with natural splines with 6 knots for age, one knot per 4 years of period and 4 knots for cohort.

It is well-known that there is no way to identify the three separate effects, but we are only using the *predicted* rates from the model at pre-specified ages and dates. And these are well-defined independent of the chosen parametrization [1].

For each data source, sex and ages 20.5, 21.5, ... 89.5 we computed the predicted rates at select dates (period), using dates 4 years apart across the range of data for the data source. These were plotted as functions of age, one for each chosen date. Confidence intervals were computed as Wald-confidence intervals (backtransformed from log-rates ± 1.96 s.e.).

Also for each data source, sex and ages 40, 50, 60, 70 and 80 we computed the predicted rates for the period of observation for the data source, that is 5 curves for each sex. These were plotted as functions of period, one for each age.

The curves were all plotted with shaded areas as confidence intervals; these are however so narrow for most data sources that they do not show up in the plots.

These plots shows how incidence rates of diabetes depend on age and calendar time (period), and are shown in figures A15–A38 as reference.

3.2 Direct standardization

We obtained the age-distribution of the EU standard population as of 2010 in 1-year age-classes, and used these as weights in direct standardization on the log incidence scale.

Specifically, we used the age-period-cohort model to provide estimates (and the corresponding variance-covariance matrix) of the log-incidence rates for ages in 1-year classes at the midpoint of each year. We then computed the weighted average of these age-specific log-incidence rates using the EU standard population 2010 distribution as weights. The calculation was done as a matrix multiplication of the log-rates, which allows a parallel calculation of the variance of the weighted average. These were then exponentiated to the standardized rates with confidence intervals.

These calculations were done separately for men and women, as well as across men and women using equal weights for men and women.

Thus, the standardized rates are based on estimates from age-period-cohort models, a smoothed version of the observed rates, as can be seen from comparing figures A1 and A2. The data source-specific standardized rates as functions of time are in figure A3.

3.3 Join point modeling

In order to provide estimates of changes in average trends by calendar time, we fitted join-point models for the rates using join points, $J = 2009$, 2010, 2011 and 2012. We use the notation:

$$x_- = \min(x, 0), \qquad x_+ = \max(x, 0)$$

that is, the minus subscript takes only the negative part of x, and the plus subscript only the positive part. We fitted the model:

$$\log\big(\lambda(a,p)\big) = f(a) + \beta_{\text{pre}}(p-J)_- + \beta_{\text{post}}(p-J)_+$$

that is a model with a join point at J and a log-linear slope β_{pre} to the left of J and a log-linear slope β_{post} to the right of J. A log-linear slope is the the same as a constant annual *relative* change, and these annual changes are reported in percent, *e.g.* $\big(\exp(\beta_{\text{pre}}) - 1\big) \times 100$.

This model was fitted separately for each data source, sex and join point.

We also fitted models for the two sexes together, constraining age-and period effects to be identical between the sexes:

$$\log\big(\lambda(a,p)\big) = f(a) + \gamma_{\text{sex}} + \beta_{\text{pre}}(p-J)_- + \beta_{\text{post}}(p-J)_+$$

The estimates $\hat{\beta}_{\text{pre}}$ and $\hat{\beta}_{\text{post}}$ are shown in the tables A7–A14.

3.3.1 Data points used

Since we are using the midpoint of the year as the period variable (p), and the beginning of the year as join point, it is in principle possible to estimate a pre- and post-join point slopes based with only one point pre or post the join point. We have however restricted the estimates to those based on at least two points pre and post the join point.

3.3.2 Reporting changes in rates

In order to visualize the pre and post join point slopes these were plotted against each other for each join point. We computed the variance of the estimated differences in slopes, $\text{var}(\hat{\beta}_{\text{pre}} - \hat{\beta}_{\text{post}})$ and used this to scale the plotting symbol so that data sources with large uncertainty are small and data sources with large precision are large. These are shown by sex in figure A39, and for both sexes in A40.

3.4 Documentation of analyses

All analysis code underlying the results in the paper and the Appendix are available in the document http://bendixcarstensen.com/IDI/global/globDM.pdf.

References

[1] B Carstensen. Age-Period-Cohort models for the Lexis diagram. *Statistics in Medicine*, 26(15):3018–3045, July 2007.

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4 Statistical tables

Table A4: *Standardized rates (per 1000 PY) by data source 1995–2003, using the European 2010 population as standard. Note the overlap with the next table.*

	Calendar year								
	1995	1996	1997	1998	1999	2000	2001	2002	2003
Australia								2.4	2.5
Canada						5.3	5.4	5.6	5.8
Denmark		1.6	1.8	1.9	2.0	2.1	2.2	2.4	2.4
France									
HongKong									
Hungary									
Israel(CHS)									
Israel(MHS)							5.8	5.4	5.0
Italy								7.1	6.5
Korea(South)									
Latvia					1.1	1.2	1.2	1.3	1.4
Lithuania									1.6
Netherlands									
Norway									
Russia						0.5	0.6	0.7	0.7
Scotland									
Singapore									
Spain									
Taiwan								8.0	7.6
UK						2.2	2.3	2.3	2.4
Ukraine									
USA(KPNW)	4.0	4.2	4.4	4.6	4.7	4.9	4.9	4.9	4.7
USA(Medicare)							26.6	28.0	29.3
USA(NHIS)	5.2	5.7	6.2	6.7	7.3	8.0	8.6	9.0	9.4

Table A5: *Standardized rates (per 1000 PY) by data source 2002–2011, using the European 2010 population as standard. Note the overlap with the previous and next tables.*

	Calendar year									
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Australia	2.4	2.5	2.5	2.5	2.6	2.7	2.9	3.0	3.1	3.0
Canada	5.6	5.8	6.0	6.1	6.2	6.2	6.1	6.0	5.9	5.8
Denmark	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.0
France										
HongKong				3.9	4.0	4.1	4.2	4.3	4.4	4.4
Hungary								4.0	3.7	3.4
Israel(CHS)			9.3	9.0	8.7	8.5	8.2	7.9	7.6	7.3
Israel(MHS)	5.4	5.0	4.7	4.5	4.3	4.2	4.1	4.2	4.2	4.2
Italy	7.1	6.5	6.0	5.5	5.1	4.8	4.6	4.5	4.3	4.2
Korea(South)					4.8	4.7	4.7	4.7	4.7	4.6
Latvia	1.3	1.4	1.5	1.7	1.8	1.9	2.0	1.9	1.9	1.8
Lithuania		1.6	1.7	1.7	1.8	1.8	1.9	1.9	2.0	2.1
Netherlands										4.4
Norway								3.3	3.1	2.9
Russia	0.7	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.3
Scotland			2.5	2.6	2.6	2.6	2.7	2.7	2.7	2.7
Singapore										
Spain						3.0	3.1	3.2	3.2	3.2
Taiwan	8.0	7.6	7.2	6.8	6.5	6.3	6.1	5.9	5.7	5.5
UK	2.3	2.4	2.4	2.3	2.1	1.9	1.8	1.7	1.6	1.6
Ukraine				0.9	1.0	1.1	1.2	1.3	1.4	
USA(KPNW)	4.9	4.7	4.5	4.4	4.5	4.8	5.2	5.8	6.2	6.4
USA(Medicare)	28.0	29.3	30.6	31.5	31.9	31.6	30.9	29.8	28.7	27.6
USA(NHIS)	9.0	9.4	9.6	9.7	9.8	10.0	10.1	10.2	10.1	9.8

Table A6: *Standardized rates (per 1000 PY) by data source 2010–2018, using the European 2010 population as standard. Note the overlap with the previous table.*

	Calendar year								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Australia	3.1	3.0	2.8	2.6	2.4	2.1			
Canada	5.9	5.8	5.7	5.5	5.4	5.3			
Denmark	3.0	3.0	2.9	2.8	2.6	2.4	2.2		
France			3.5	3.5	3.4	3.4	3.4	3.3	
HongKong	4.4	4.4	4.4	4.4	4.3	4.2	4.2		
Hungary	3.7	3.4	3.2	3.0	2.8	2.6	2.4		
Israel(CHS)	7.6	7.3	7.0	6.6	6.3	6.0	5.7		
Israel(MHS)	4.2	4.2	4.2	4.2	4.1	4.0			
Italy	4.3	4.2	4.1						
Korea(South)	4.7	4.6	4.6	4.5	4.4	4.4			
Latvia	1.9	1.8	1.7	1.7	1.7	1.7	1.6		
Lithuania	2.0	2.1	2.1	2.2	2.4	2.5	2.7		
Netherlands		4.4	4.2	4.0	3.9	3.7	3.6		
Norway	3.1	2.9	2.8	2.6	2.5				
Russia	1.3	1.3	1.2	1.1	1.1	1.1	1.0	1.0	1.0
Scotland	2.7	2.7	2.7	2.7	2.7	2.6			
Singapore			5.5	5.7	5.8	6.0	6.1		
Spain	3.2	3.2	3.0	2.8	2.5	2.3	2.1		
Taiwan	5.7	5.5							
UK	1.6	1.6	1.5	1.4					
Ukraine	1.4								
USA(KPNW)	6.2	6.4	6.4	6.4	6.7	7.0	7.4		
USA(Medicare)	28.7	27.6	26.5	25.3	24.3	23.3			
USA(NHIS)	10.1	9.8	9.4	9.0	8.5	8.0			

Table A7: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2009, based on a model with common secular trend for men and women, controlling for sex.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2007 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2010 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	<2009			>2009		
	%/y	95% CI		%/y	95% CI	
Australia	4.2	4.1	4.3	−4.6	−4.7	−4.5
Canada	1.1	1.1	1.2	−3.3	−3.4	−3.3
Denmark	3.9	3.8	4.0	−3.7	−3.9	−3.5
France	.	.	.	−1.9	−2.0	−1.8
HongKong	1.7	1.3	2.0	−0.6	−0.7	−0.5
Hungary	.	.	.	−7.6	−7.7	−7.4
Israel(CHS)	−3.9	−4.1	−3.6	−5.2	−5.3	−5.0
Israel(MHS)	−4.1	−4.4	−3.8	0.6	0.3	0.9
Italy	−5.2	−5.3	−5.1	−0.9	−1.2	−0.7
Korea(South)	−2.2	−3.4	−0.9	−2.1	−2.5	−1.6
Latvia	4.9	4.6	5.1	−3.5	−3.7	−3.2
Lithuania	2.3	1.9	2.7	4.0	3.7	4.3
Netherlands	.	.	.	−5.3	−5.9	−4.6
Norway	.	.	.	−7.6	−7.9	−7.2
Russia	11.9	11.9	12.0	−2.4	−2.5	−2.4
Scotland	0.4	0.0	0.7	−1.2	−1.5	−1.0
Singapore	.	.	.	2.2	1.8	2.6
Spain	8.5	7.4	9.6	−5.3	−5.5	−5.1
Taiwan	−4.3	−4.7	−3.9	−3.6	−4.8	−2.3
UK	−3.7	−3.8	−3.5	−7.0	−7.4	−6.7
Ukraine	14.6	12.4	16.8	3.2	−1.0	7.7
USA(KPNW)	1.0	0.7	1.2	4.2	3.8	4.6
USA(Medicare)	2.0	1.9	2.0	−4.9	−5.0	−4.9
USA(NHIS)	4.0	3.2	4.8	−4.9	−6.3	−3.4

Table A 8: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2009, estimated separately for men and women.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2007 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2010 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	Men						Women					
	<2009			>2009			<2009			>2009		
	%/y	95% CI		%/y	95% CI		%/y	95% CI		%/y	95% CI	
Australia	5.0	4.9	5.2	−4.1	−4.3	−4.0	3.2	3.0	3.4	−5.3	−5.4	−5.1
Canada	1.3	1.3	1.4	−3.2	−3.3	−3.1	0.9	0.9	1.0	−3.6	−3.7	−3.5
Denmark	3.9	3.8	4.1	−3.3	−3.6	−3.1	3.9	3.8	4.1	−4.1	−4.4	−3.9
France	.	.	.	−1.7	−1.8	−1.6	.	.	.	−2.1	−2.3	−2.0
HongKong	3.0	2.6	3.5	0.2	0.1	0.4	0.2	−0.2	0.7	−1.5	−1.7	−1.3
Hungary	.	.	.	−7.4	−7.6	−7.1	.	.	.	−7.8	−8.0	−7.6
Israel(CHS)	−4.6	−4.9	−4.2	−4.4	−4.6	−4.2	−3.2	−3.5	−2.8	−6.0	−6.2	−5.7
Israel(MHS)	−4.0	−4.4	−3.6	1.1	0.6	1.5	−4.2	−4.6	−3.8	0.1	−0.4	0.6
Italy	−4.8	−5.0	−4.7	−2.4	−2.8	−2.0	−5.6	−5.7	−5.4	0.6	0.3	1.0
Korea(South)	−1.1	−2.8	0.7	−1.8	−2.4	−1.1	−3.3	−5.2	−1.4	−2.4	−3.1	−1.7
Latvia	7.4	7.0	7.8	−2.3	−2.7	−1.8	3.6	3.4	3.9	−4.3	−4.6	−3.9
Lithuania	4.8	4.1	5.5	4.8	4.3	5.2	0.6	0.1	1.2	3.3	3.0	3.7
Netherlands	.	.	.	−4.3	−5.2	−3.4	.	.	.	−6.3	−7.3	−5.4
Norway	.	.	.	−6.7	−7.1	−6.2	.	.	.	−8.7	−9.2	−8.2
Russia	14.2	14.1	14.3	−0.6	−0.7	−0.5	11.1	11.0	11.2	−3.3	−3.4	−3.3
Scotland	1.7	1.2	2.1	−1.3	−1.6	−1.0	−1.1	−1.7	−0.6	−1.2	−1.6	−0.9
Singapore	.	.	.	2.7	2.2	3.3	.	.	.	1.7	1.1	2.3
Spain	8.1	6.7	9.6	−5.3	−5.5	−5.0	9.0	7.4	10.7	−5.3	−5.6	−5.1
Taiwan	−3.4	−4.0	−2.8	−2.1	−3.8	−0.5	−5.3	−5.9	−4.7	−5.3	−7.0	−3.5
UK	−3.1	−3.4	−2.9	−6.9	−7.3	−6.4	−4.3	−4.6	−4.1	−7.2	−7.8	−6.7
Ukraine	11.5	8.2	15.0	1.6	−5.1	8.7	16.7	13.8	19.6	4.3	−1.1	10.0
USA(KPNW)	0.8	0.4	1.1	3.5	2.9	4.0	1.2	0.9	1.6	5.0	4.4	5.6
USA(Medicare)	2.0	2.0	2.1	−4.3	−4.4	−4.3	1.9	1.9	2.0	−5.4	−5.5	−5.4
USA(NHIS)	4.6	3.3	5.8	−6.7	−8.8	−4.4	3.5	2.4	4.6	−3.5	−5.5	−1.5

Table A9: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2010, based on a model with common secular trend for men and women, controlling for sex.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2008 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2011 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	<2010			>2010		
	%/y	95% CI		%/y	95% CI	
Australia	3.5	3.4	3.6	−6.0	−6.1	−5.9
Canada	0.7	0.7	0.8	−3.8	−3.8	−3.7
Denmark	3.7	3.6	3.8	−4.9	−5.1	−4.8
France	.	.	.	−1.9	−2.0	−1.8
HongKong	1.7	1.5	2.0	−1.1	−1.2	−0.9
Hungary	.	.	.	−8.1	−8.3	−7.9
Israel(CHS)	−3.9	−4.1	−3.7	−5.4	−5.6	−5.2
Israel(MHS)	−3.5	−3.7	−3.3	0.9	0.5	1.2
Italy	−4.5	−4.6	−4.3	−1.7	−2.1	−1.3
Korea(South)	−1.7	−2.6	−0.8	−2.3	−2.9	−1.8
Latvia	4.2	4.0	4.4	−4.3	−4.6	−3.9
Lithuania	2.2	1.9	2.6	4.4	4.0	4.7
Netherlands	.	.	.	−5.3	−5.9	−4.6
Norway	.	.	.	−7.5	−8.0	−7.1
Russia	10.5	10.4	10.5	−3.4	−3.4	−3.3
Scotland	0.3	0.0	0.6	−1.6	−1.8	−1.3
Singapore	.	.	.	2.2	1.8	2.6
Spain	5.3	4.7	5.9	−6.4	−6.6	−6.2
Taiwan	−4.1	−4.4	−3.7	−4.9	−7.0	−2.8
UK	−4.0	−4.1	−3.8	−7.4	−7.8	−6.9
Ukraine	13.0	11.3	14.7	.	.	.
USA(KPNW)	1.2	1.0	1.4	4.3	3.8	4.8
USA(Medicare)	1.3	1.2	1.3	−5.6	−5.6	−5.5
USA(NHIS)	3.5	2.7	4.2	−6.0	−7.7	−4.2

Table A10: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2010, estimated separately for men and women.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2008 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2011 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	Men						Women					
	<2010			>2010			<2010			>2010		
	%/y	95% CI		%/y	95% CI		%/y	95% CI		%/y	95% CI	
Australia	4.3	4.2	4.4	−5.5	−5.7	−5.3	2.6	2.4	2.8	−6.6	−6.8	−6.4
Canada	0.9	0.9	1.0	−3.6	−3.7	−3.5	0.5	0.4	0.6	−3.9	−4.1	−3.8
Denmark	3.7	3.6	3.8	−4.5	−4.8	−4.3	3.6	3.5	3.8	−5.5	−5.7	−5.2
France	.	.	.	−1.7	−1.8	−1.6	.	.	.	−2.1	−2.3	−2.0
HongKong	3.0	2.7	3.3	−0.2	−0.4	−0.0	0.4	0.1	0.8	−2.0	−2.2	−1.7
Hungary	.	.	.	−7.7	−8.0	−7.5	.	.	.	−8.5	−8.8	−8.3
Israel(CHS)	−4.4	−4.7	−4.1	−4.5	−4.7	−4.2	−3.4	−3.7	−3.1	−6.4	−6.6	−6.1
Israel(MHS)	−3.4	−3.8	−3.1	1.4	0.9	2.0	−3.6	−4.0	−3.2	0.2	−0.4	0.8
Italy	−4.3	−4.4	−4.1	−3.6	−4.1	−3.0	−4.7	−4.8	−4.5	0.3	−0.2	0.9
Korea(South)	−1.0	−2.2	0.2	−1.9	−2.7	−1.2	−2.3	−3.6	−1.0	−2.7	−3.5	−1.9
Latvia	6.5	6.2	6.9	−3.1	−3.6	−2.5	3.1	2.8	3.3	−5.1	−5.5	−4.7
Lithuania	4.4	3.8	5.0	5.1	4.6	5.6	0.8	0.3	1.2	3.8	3.3	4.2
Netherlands	.	.	.	−4.3	−5.2	−3.4	.	.	.	−6.3	−7.3	−5.4
Norway	.	.	.	−6.5	−7.1	−5.9	.	.	.	−8.8	−9.5	−8.1
Russia	12.6	12.5	12.7	−1.5	−1.6	−1.4	9.7	9.6	9.7	−4.3	−4.4	−4.3
Scotland	1.3	1.0	1.7	−1.7	−2.0	−1.3	−1.0	−1.4	−0.6	−1.4	−1.8	−1.0
Singapore	.	.	.	2.7	2.2	3.3	.	.	.	1.7	1.1	2.3
Spain	4.8	4.0	5.6	−6.3	−6.5	−6.0	6.1	5.1	7.0	−6.6	−6.9	−6.3
Taiwan	−3.0	−3.5	−2.5	−4.3	−7.1	−1.4	−5.3	−5.8	−4.8	−5.8	−8.8	−2.7
UK	−3.4	−3.6	−3.2	−7.5	−8.1	−6.9	−4.7	−4.9	−4.4	−7.2	−7.9	−6.5
Ukraine	10.5	7.9	13.2	.	.	.	14.6	12.4	16.9	.	.	.
USA(KPNW)	0.9	0.6	1.2	3.7	3.0	4.3	1.6	1.3	1.9	5.0	4.3	5.7
USA(Medicare)	1.4	1.3	1.4	−4.9	−5.0	−4.8	1.2	1.2	1.2	−6.1	−6.2	−6.1
USA(NHIS)	3.9	2.8	5.1	−8.0	−10.6	−5.3	3.1	2.1	4.1	−4.4	−6.7	−2.0

Table A11: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2011, based on a model with common secular trend for men and women, controlling for sex.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2009 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2012 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	<2011			>2011		
	%/y	95% CI		%/y	95% CI	
Australia	2.9	2.9	3.0	−8.0	−8.2	−7.8
Canada	0.3	0.3	0.4	−4.1	−4.2	−4.0
Denmark	3.4	3.3	3.5	−6.6	−6.8	−6.4
France	.	.	.	−1.9	−2.0	−1.8
HongKong	1.7	1.5	1.8	−1.7	−1.8	−1.5
Hungary	−3.8	−4.6	−3.0	−8.3	−8.5	−8.1
Israel(CHS)	−4.0	−4.1	−3.8	−5.8	−6.0	−5.5
Israel(MHS)	−3.0	−3.2	−2.8	1.1	0.6	1.6
Italy	−3.9	−4.0	−3.8	−4.8	−5.4	−4.1
Korea(South)	−1.5	−2.2	−0.8	−2.7	−3.3	−2.0
Latvia	3.6	3.4	3.8	−5.1	−5.5	−4.7
Lithuania	2.2	1.9	2.5	5.0	4.6	5.4
Netherlands	.	.	.	−5.3	−5.9	−4.6
Norway	−10.3	−11.6	−9.1	−6.5	−7.0	−5.9
Russia	9.2	9.1	9.2	−4.4	−4.4	−4.3
Scotland	0.1	−0.1	0.3	−1.8	−2.2	−1.5
Singapore	.	.	.	2.2	1.8	2.6
Spain	2.9	2.5	3.3	−7.6	−7.9	−7.4
Taiwan	−4.0	−4.3	−3.7	.	.	.
UK	−4.2	−4.4	−4.1	−7.6	−8.3	−6.9
Ukraine	11.3	10.1	12.6	.	.	.
USA(KPNW)	1.4	1.2	1.6	4.4	3.8	5.0
USA(Medicare)	0.7	0.7	0.7	−6.4	−6.4	−6.3
USA(NHIS)	3.0	2.3	3.7	−7.3	−9.5	−5.1

Table A12: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2011, estimated separately for men and women.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2009 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2012 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	Men						Women					
	<2011			>2011			<2011			>2011		
	%/y	95% CI		%/y	95% CI		%/y	95% CI		%/y	95% CI	
Australia	3.7	3.6	3.8	−7.5	−7.7	−7.3	2.1	1.9	2.2	−8.6	−8.9	−8.4
Canada	0.5	0.5	0.6	−4.0	−4.1	−3.8	0.1	0.0	0.2	−4.2	−4.4	−4.1
Denmark	3.4	3.3	3.5	−6.1	−6.4	−5.8	3.4	3.3	3.5	−7.3	−7.6	−6.9
France	.	.	.	−1.7	−1.8	−1.6	.	.	.	−2.1	−2.3	−2.0
HongKong	2.8	2.6	3.1	−0.8	−1.1	−0.6	0.4	0.2	0.7	−2.5	−2.8	−2.3
Hungary	−5.4	−6.5	−4.3	−7.8	−8.1	−7.5	−2.2	−3.3	−1.1	−8.9	−9.2	−8.6
Israel(CHS)	−4.4	−4.6	−4.1	−4.6	−4.9	−4.3	−3.6	−3.8	−3.3	−6.9	−7.3	−6.6
Israel(MHS)	−3.0	−3.3	−2.7	1.9	1.2	2.5	−3.1	−3.4	−2.8	0.2	−0.5	0.9
Italy	−3.9	−4.0	−3.8	−6.8	−7.8	−5.9	−3.9	−4.1	−3.8	−2.6	−3.5	−1.6
Korea(South)	−1.0	−1.9	−0.1	−2.2	−3.1	−1.3	−2.0	−3.0	−1.0	−3.1	−4.1	−2.1
Latvia	5.7	5.4	6.0	−3.8	−4.5	−3.2	2.5	2.3	2.8	−6.1	−6.6	−5.6
Lithuania	4.1	3.6	4.6	5.7	5.1	6.3	0.9	0.5	1.3	4.4	3.8	4.9
Netherlands	.	.	.	−4.3	−5.2	−3.4	.	.	.	−6.3	−7.3	−5.4
Norway	−9.6	−11.3	−8.0	−5.5	−6.3	−4.7	−11.2	−13.0	−9.3	−7.7	−8.6	−6.8
Russia	11.2	11.1	11.2	−2.4	−2.5	−2.3	8.4	8.4	8.5	−5.4	−5.4	−5.3
Scotland	1.0	0.7	1.3	−2.1	−2.5	−1.6	−1.0	−1.3	−0.6	−1.5	−2.1	−1.0
Singapore	.	.	.	2.7	2.2	3.3	.	.	.	1.7	1.1	2.3
Spain	2.4	1.8	2.9	−7.4	−7.7	−7.0	3.7	3.1	4.3	−8.0	−8.4	−7.7
Taiwan	−2.9	−3.3	−2.4	.	.	.	−5.3	−5.7	−4.8	.	.	.
UK	−3.7	−3.9	−3.5	−8.1	−9.1	−7.2	−4.9	−5.1	−4.7	−6.9	−8.0	−5.9
Ukraine	8.7	6.8	10.7	.	.	.	13.0	11.4	14.7	.	.	.
USA(KPNW)	1.0	0.8	1.3	4.0	3.2	4.8	1.9	1.6	2.2	4.8	4.0	5.6
USA(Medicare)	0.9	0.8	0.9	−5.6	−5.7	−5.5	0.6	0.6	0.6	−7.0	−7.1	−7.0
USA(NHIS)	3.3	2.3	4.3	−9.4	−12.6	−6.1	2.8	1.9	3.7	−5.7	−8.6	−2.7

Table A13: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2012, based on a model with common secular trend for men and women, controlling for sex.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2010 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2013 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	<2012			>2012		
	%/y	95% CI		%/y	95% CI	
Australia	2.3	2.3	2.4	−10.8	−11.0	−10.6
Canada	−0.0	−0.1	−0.0	−4.4	−4.5	−4.3
Denmark	3.0	2.9	3.1	−8.3	−8.5	−8.0
France	.	.	.	−1.9	−2.0	−1.8
HongKong	1.4	1.3	1.6	−2.3	−2.5	−2.1
Hungary	−6.6	−7.0	−6.1	−8.1	−8.3	−7.8
Israel(CHS)	−4.2	−4.3	−4.0	−5.9	−6.2	−5.7
Israel(MHS)	−2.6	−2.8	−2.4	1.3	0.7	1.9
Italy	−3.7	−3.8	−3.6	.	.	.
Korea(South)	−1.7	−2.2	−1.1	−2.9	−3.7	−2.0
Latvia	3.0	2.9	3.2	−6.0	−6.5	−5.5
Lithuania	2.3	2.0	2.6	5.6	5.1	6.1
Netherlands	.	.	.	−2.7	−3.5	−1.8
Norway	−10.5	−11.2	−9.8	−4.2	−5.0	−3.3
Russia	8.0	8.0	8.1	−5.5	−5.5	−5.4
Scotland	−0.0	−0.2	0.2	−2.4	−2.8	−1.9
Singapore	.	.	.	2.2	1.8	2.6
Spain	1.3	1.0	1.6	−9.2	−9.5	−8.9
Taiwan	−4.1	−4.4	−3.9	.	.	.
UK	−4.4	−4.5	−4.3	−8.2	−9.4	−7.0
Ukraine	11.3	10.1	12.6	.	.	.
USA(KPNW)	1.6	1.4	1.8	4.8	4.0	5.5
USA(Medicare)	0.2	0.2	0.2	−7.3	−7.4	−7.2
USA(NHIS)	2.6	2.0	3.2	−9.1	−11.9	−6.2

Table A14: *Annual trends in incidence of diagnosed total or type 2 diabetes (% per year) before and after 2012, estimated separately for men and women.*
Join points are taken as 1 January of the year, data points are taken as the midpoint of the year of observation. A data source contributes to "before" if at least two years of observation is before the join point, that is data starts 2010 or earlier. A data source contributes to "after" if at least two years of observation is after the join point, that is data ends 2013 or later.
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

	Men						Women					
	<2012			>2012			<2012			>2012		
	%/y	95% CI		%/y	95% CI		%/y	95% CI		%/y	95% CI	
Australia	3.0	2.9	3.2	−10.4	−10.7	−10.1	1.5	1.4	1.6	−11.5	−11.8	−11.1
Canada	0.2	0.1	0.2	−4.3	−4.5	−4.1	−0.3	−0.3	−0.2	−4.5	−4.7	−4.4
Denmark	3.0	2.9	3.1	−7.5	−7.9	−7.2	3.0	2.9	3.1	−9.2	−9.6	−8.7
France	.	.	.	−1.7	−1.8	−1.6	.	.	.	−2.1	−2.3	−2.0
HongKong	2.5	2.3	2.7	−1.5	−1.8	−1.2	0.3	0.0	0.5	−3.2	−3.5	−2.9
Hungary	−7.5	−8.1	−6.8	−7.3	−7.7	−6.9	−5.7	−6.4	−5.1	−8.8	−9.2	−8.5
Israel(CHS)	−4.4	−4.6	−4.2	−4.5	−4.9	−4.1	−3.9	−4.1	−3.7	−7.4	−7.8	−7.0
Israel(MHS)	−2.6	−2.8	−2.3	2.3	1.5	3.2	−2.7	−3.0	−2.5	0.1	−0.8	1.0
Italy	−3.8	−4.0	−3.7	.	.	.	−3.6	−3.7	−3.4	.	.	.
Korea(South)	−1.2	−2.0	−0.5	−2.3	−3.5	−1.1	−2.1	−2.9	−1.3	−3.5	−4.8	−2.2
Latvia	5.0	4.7	5.3	−4.6	−5.4	−3.8	2.0	1.8	2.2	−7.0	−7.6	−6.4
Lithuania	4.1	3.6	4.5	6.3	5.6	7.1	1.1	0.8	1.4	5.1	4.4	5.7
Netherlands	.	.	.	−1.8	−3.0	−0.7	.	.	.	−3.7	−4.9	−2.4
Norway	−9.5	−10.5	−8.5	−3.5	−4.6	−2.4	−11.8	−12.9	−10.7	−5.1	−6.4	−3.8
Russia	9.9	9.9	10.0	−3.4	−3.5	−3.4	7.3	7.3	7.3	−6.5	−6.6	−6.4
Scotland	0.8	0.5	1.0	−2.8	−3.4	−2.2	−1.0	−1.3	−0.7	−1.8	−2.5	−1.1
Singapore	.	.	.	2.7	2.2	3.3	.	.	.	1.7	1.1	2.3
Spain	0.8	0.4	1.2	−8.7	−9.1	−8.3	2.0	1.5	2.5	−9.9	−10.3	−9.5
Taiwan	−3.1	−3.5	−2.8	.	.	.	−5.3	−5.7	−4.9	.	.	.
UK	−3.9	−4.1	−3.7	−9.5	−11.1	−7.9	−5.1	−5.2	−4.9	−6.6	−8.4	−4.7
Ukraine	8.7	6.8	10.7	.	.	.	13.0	11.4	14.7	.	.	.
USA(KPNW)	1.1	0.8	1.4	4.8	3.8	5.9	2.1	1.9	2.4	4.7	3.6	5.7
USA(Medicare)	0.4	0.3	0.4	−6.3	−6.5	−6.2	0.1	0.1	0.1	−8.1	−8.2	−8.0
USA(NHIS)	2.6	1.7	3.5	−10.8	−15.0	−6.4	2.5	1.7	3.3	−7.8	−11.6	−3.9

5 Figures

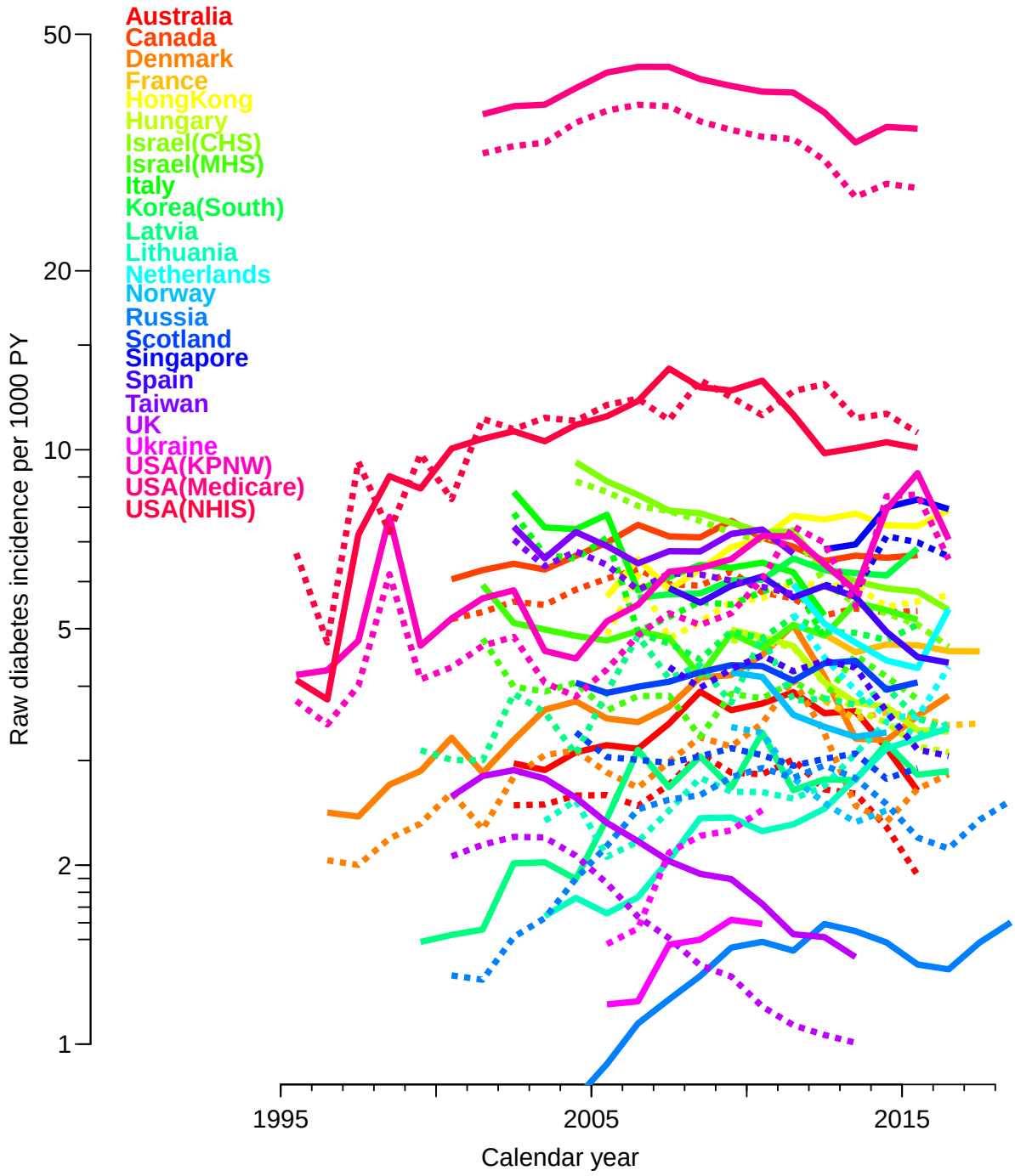

Figure A1: *Raw diagnosed total or type 2 diabetes incidence rates by data source and sex. Men in full lines, women broken lines.*

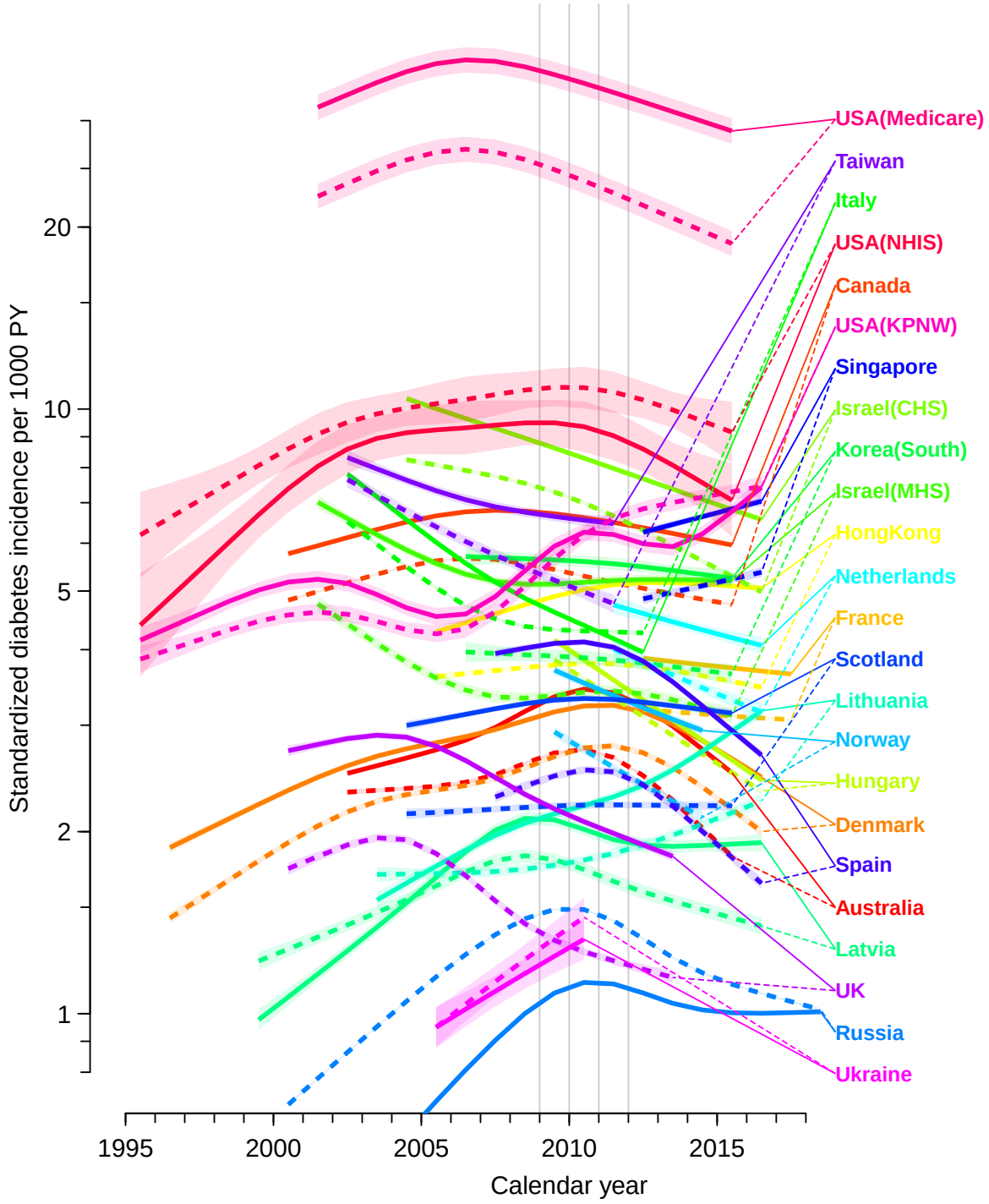

Figure A2: *Age-standardized incidence rates (EU population 2010) separately for men and women. Based on separate age-period-cohort for men and women. The vertical gray lines indicate the join points that we have investigated. Men in full lines, women broken lines.*

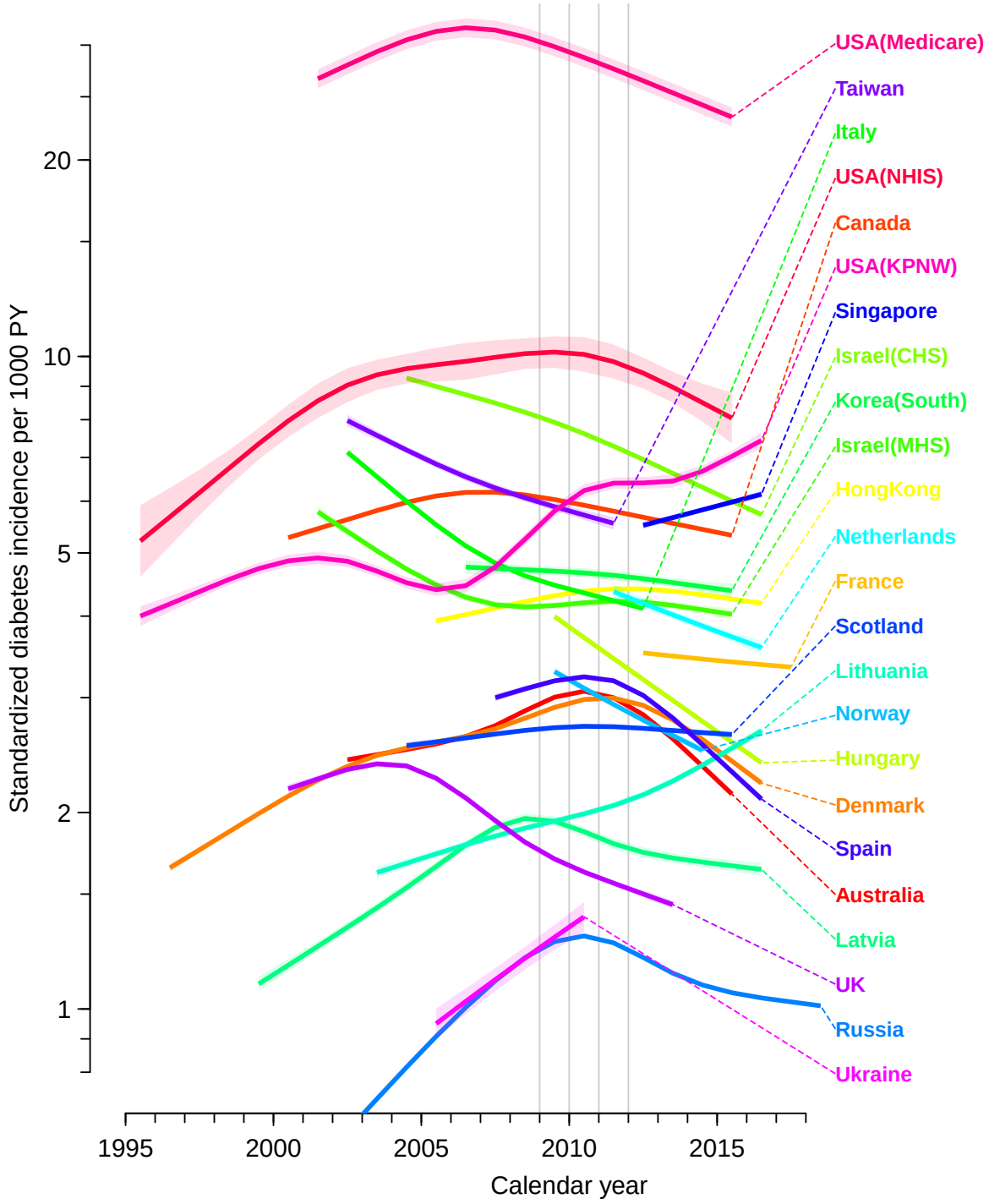

Figure A3: *Age- and sex-standardized incidence rates (EU standard population 2010, equal weights for men and women). Based on separate age-period-cohort for men and women. The vertical gray lines indicate the join points that we have investigated.*

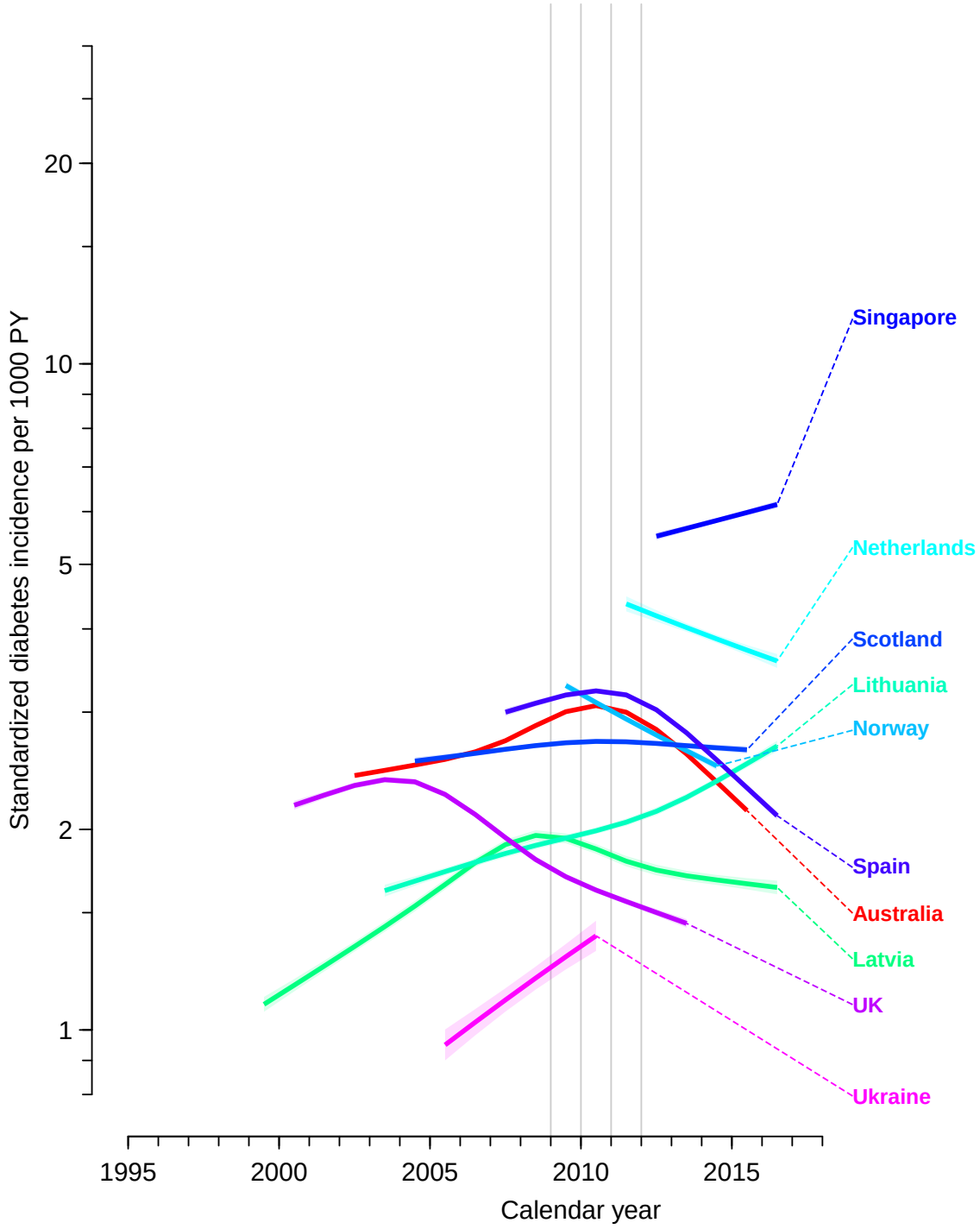

Figure A4: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on clinical assessment.*

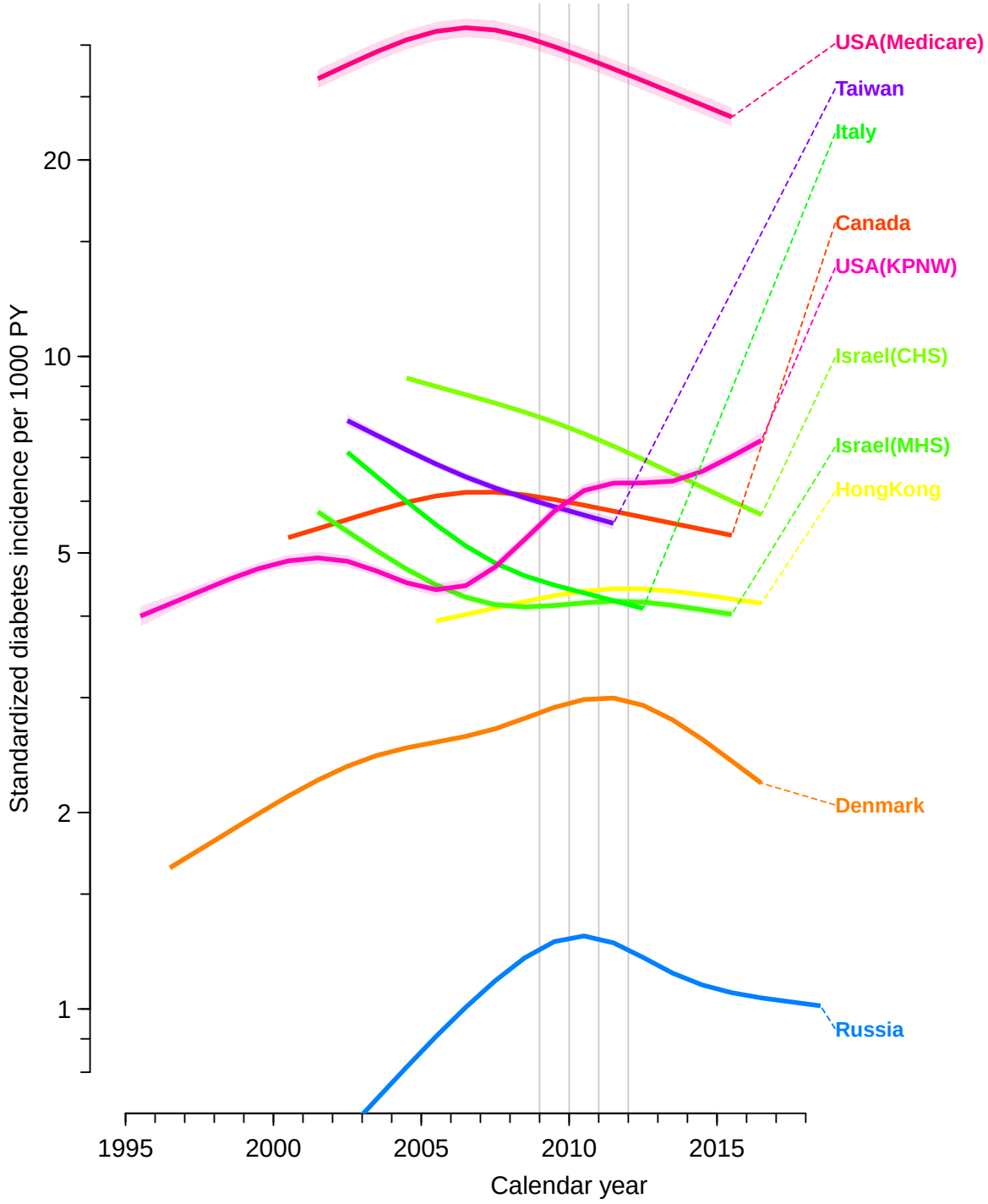

Figure A5: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on a data-derived algorithm.*

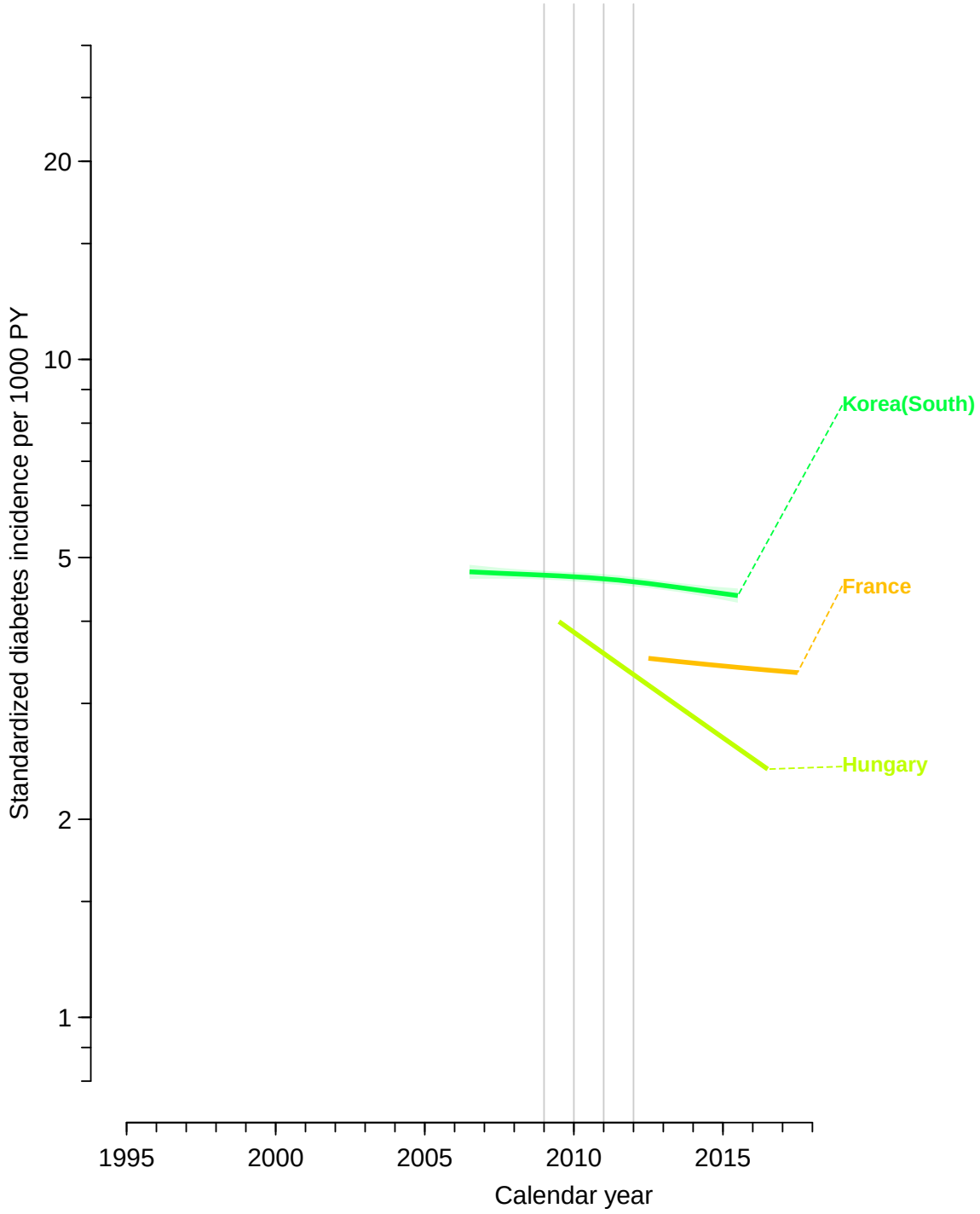

Figure A6: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on medication records.*

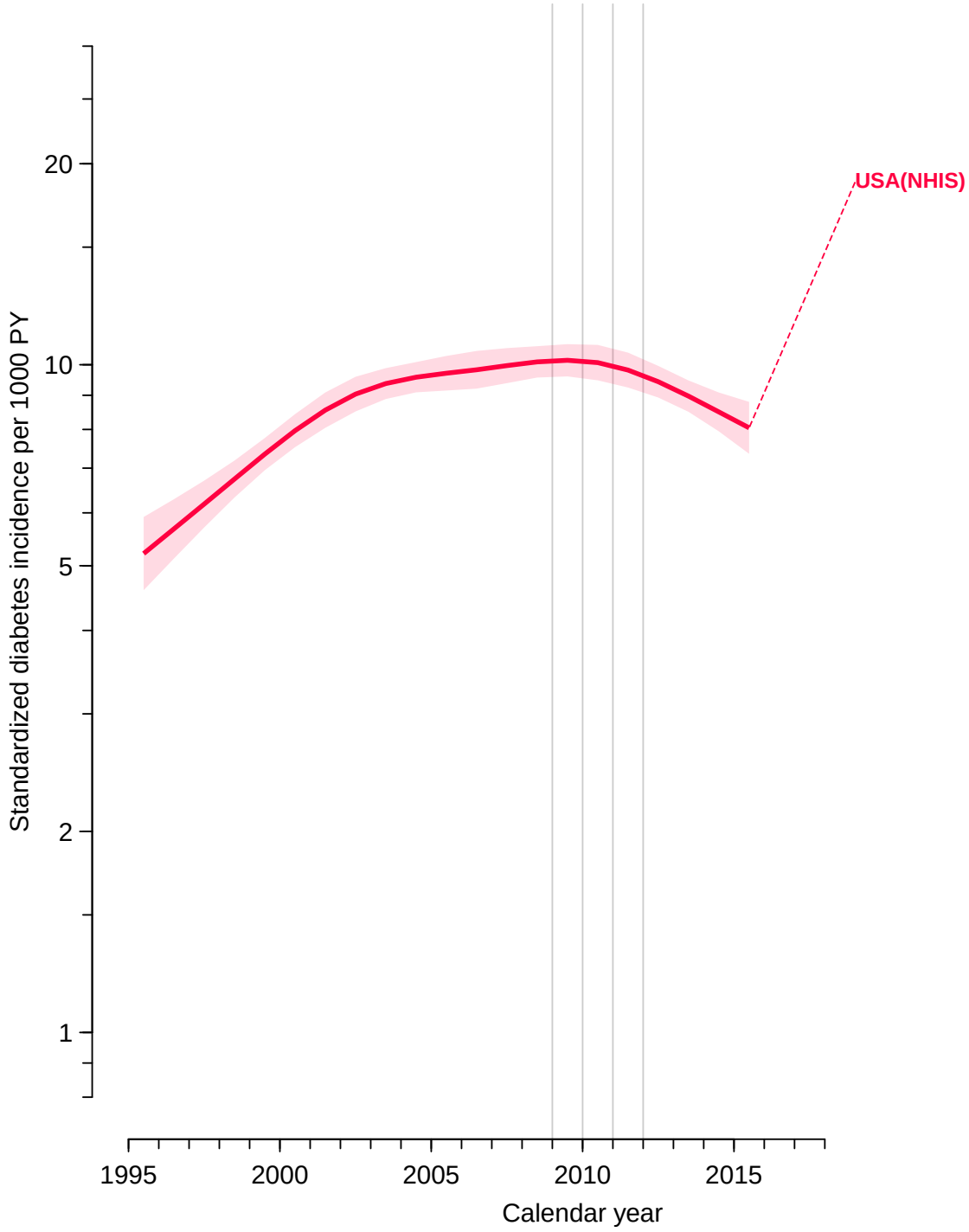

Figure A7: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on self-reported diabetes.*

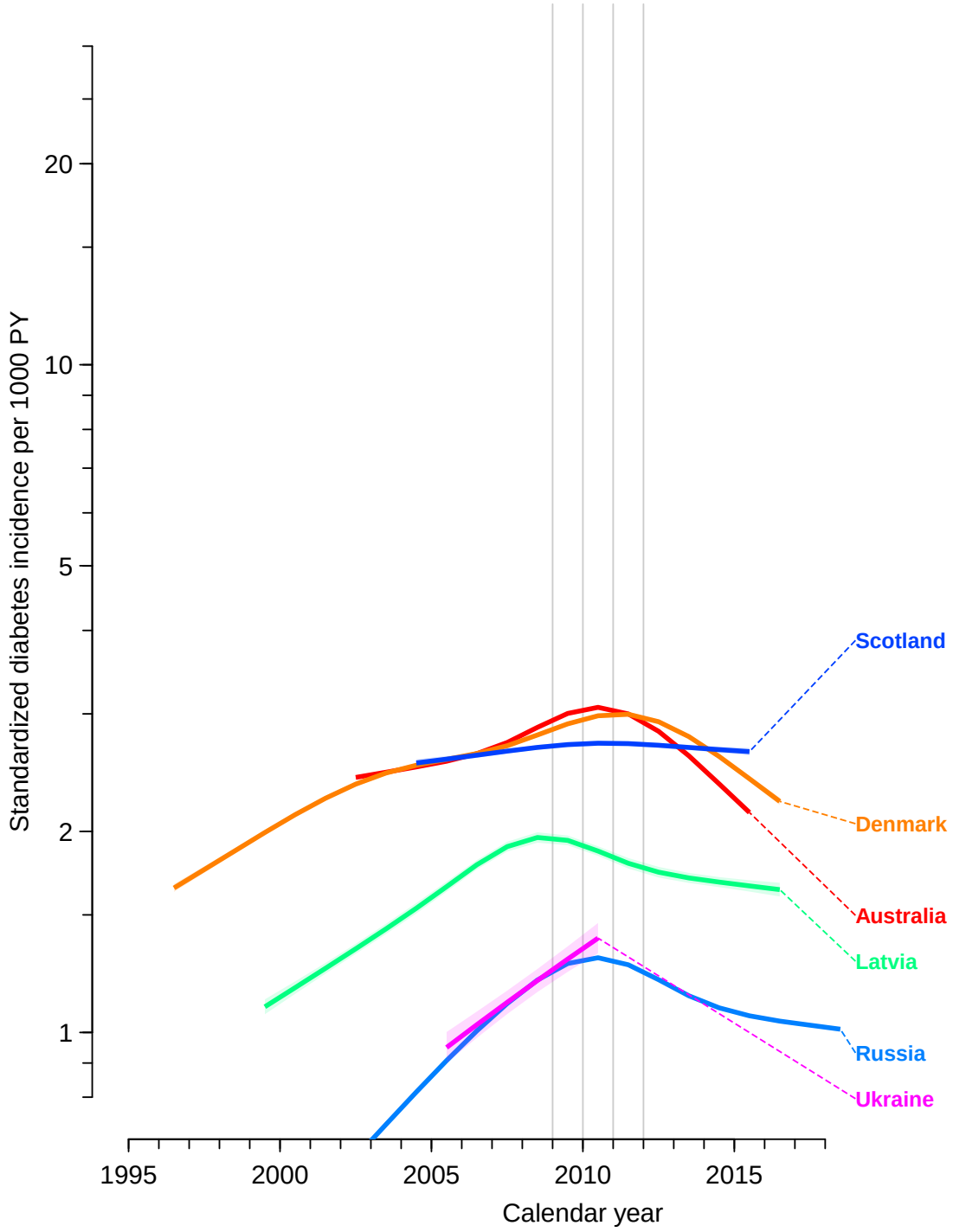

Figure A8: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on a register.*

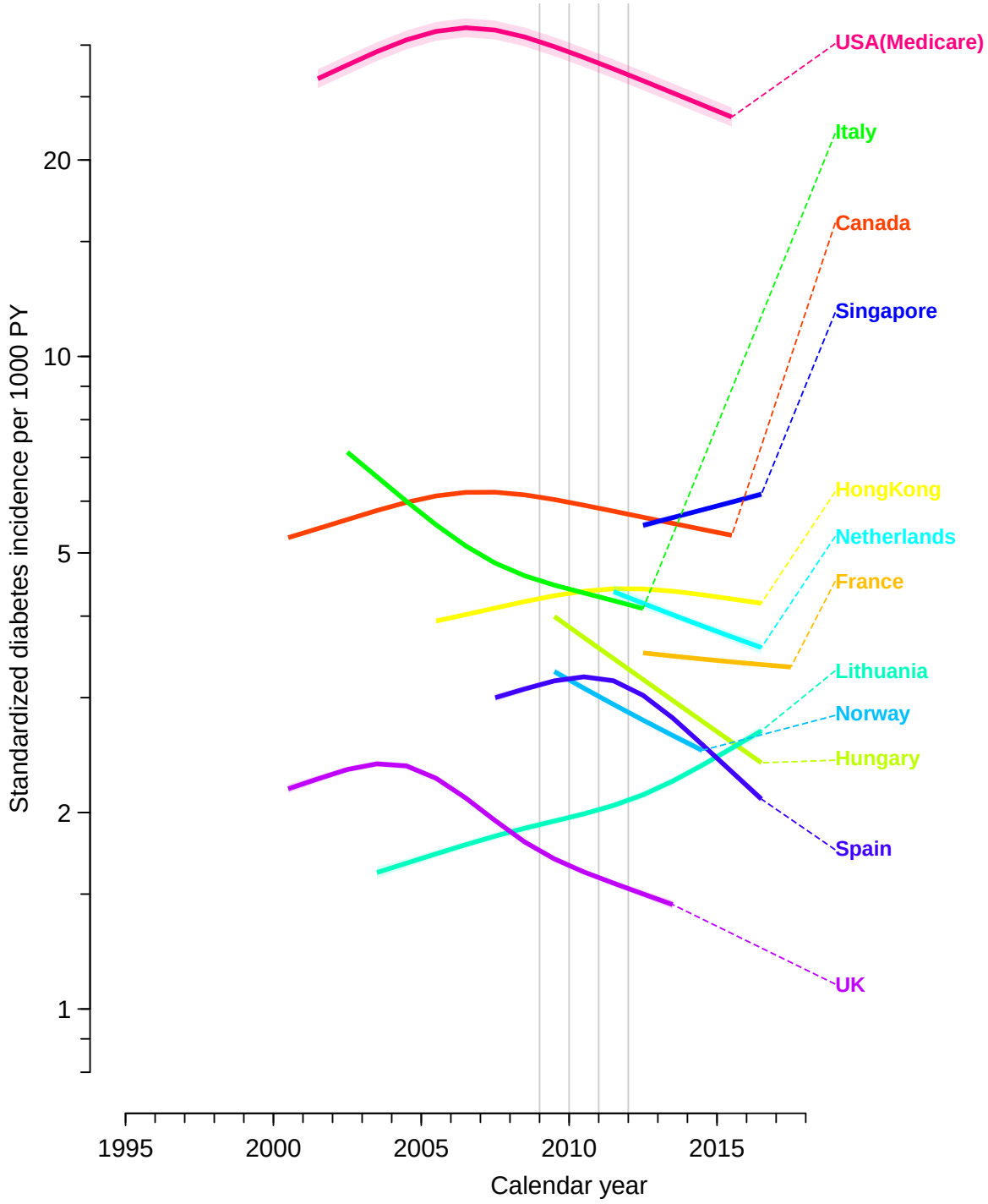

Figure A9: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on administrative data bases.*

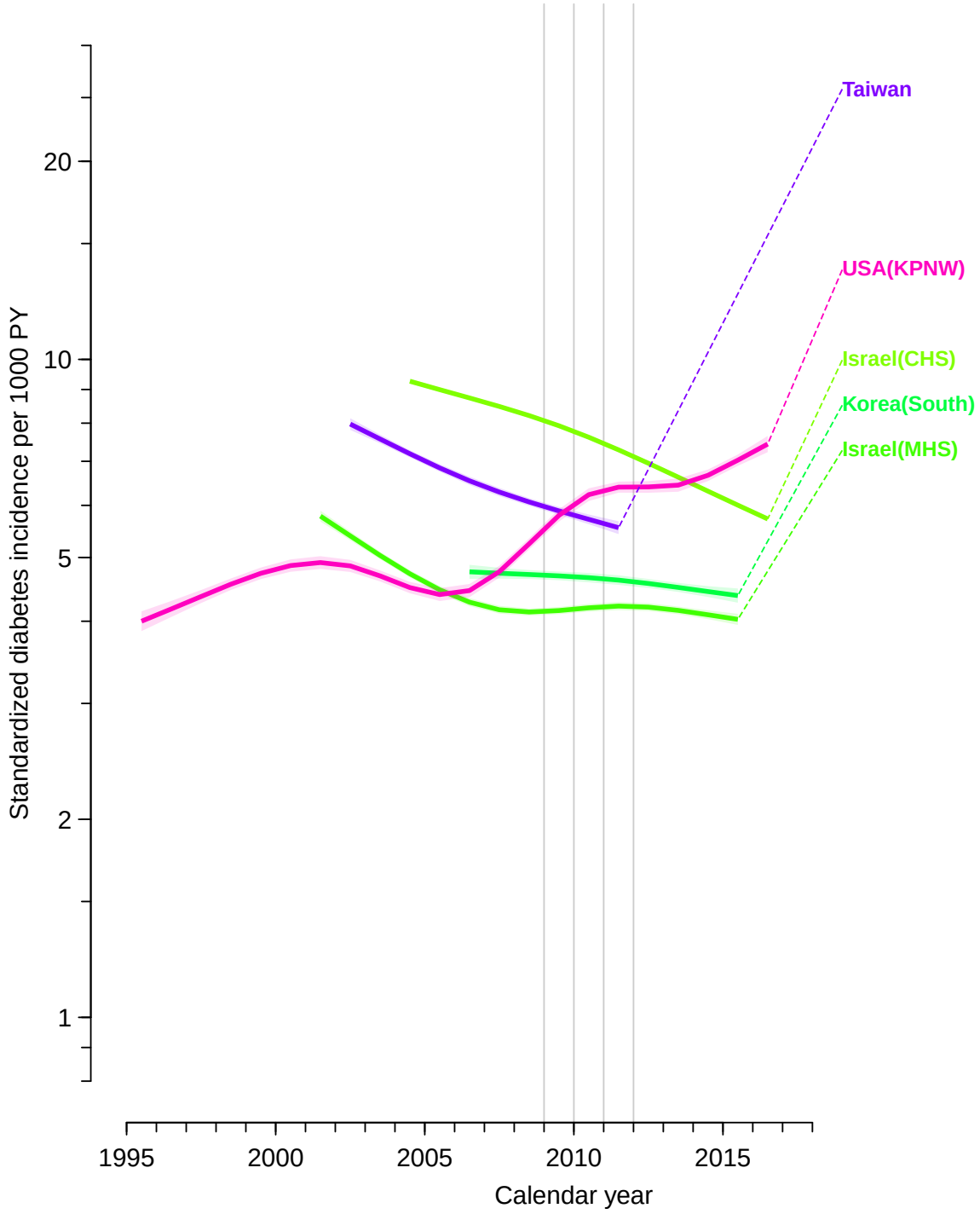

Figure A 10: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on health insurance records.*

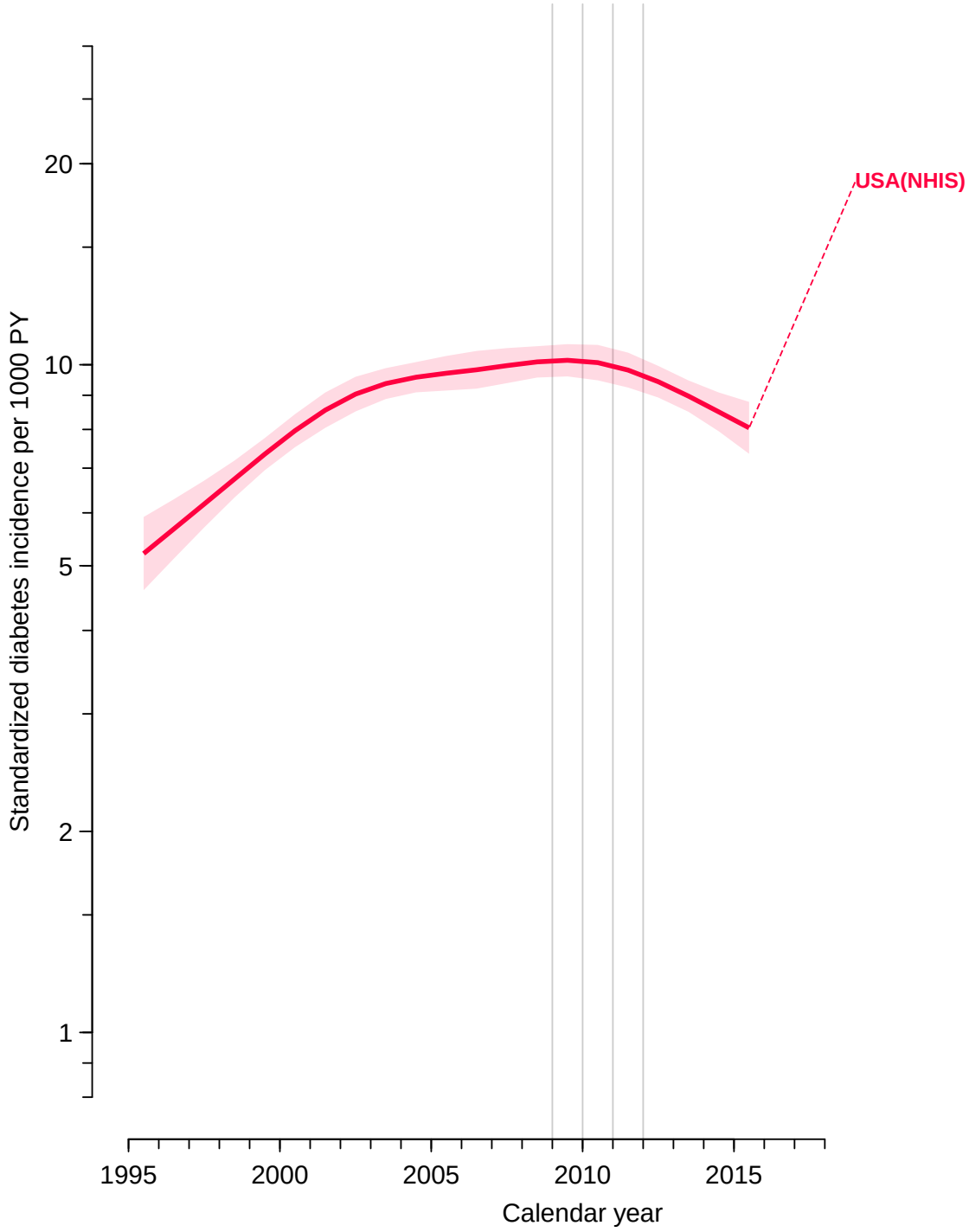

Figure A 11: *Age and sex standardized diabetes incidence rates by data source, for data sources with diabetes definition based on survey data.*

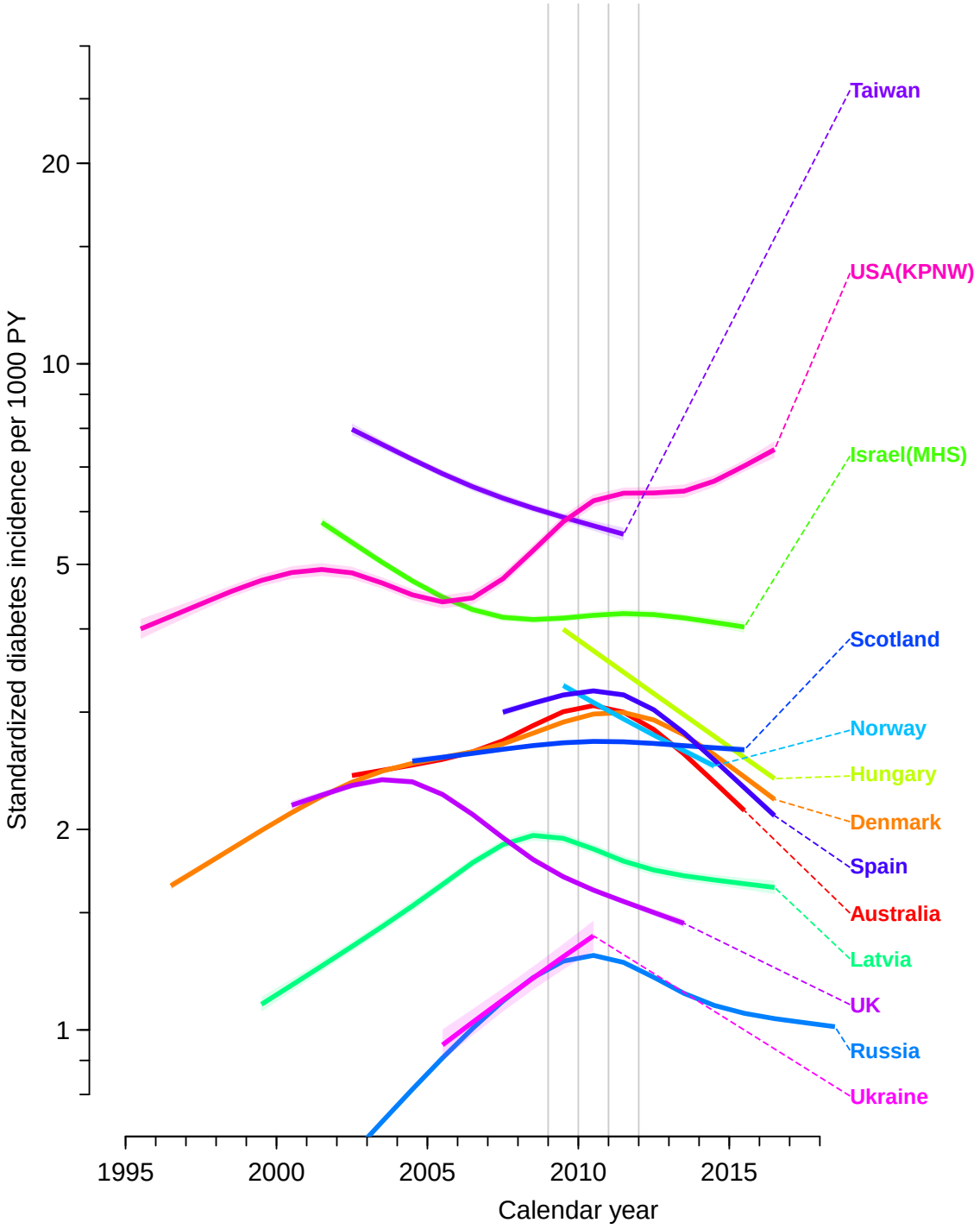

Figure A 12: *Age and sex standardized diabetes incidence rates by data source , for data sources with diabetes definition only including type 2 diabetes patients.*

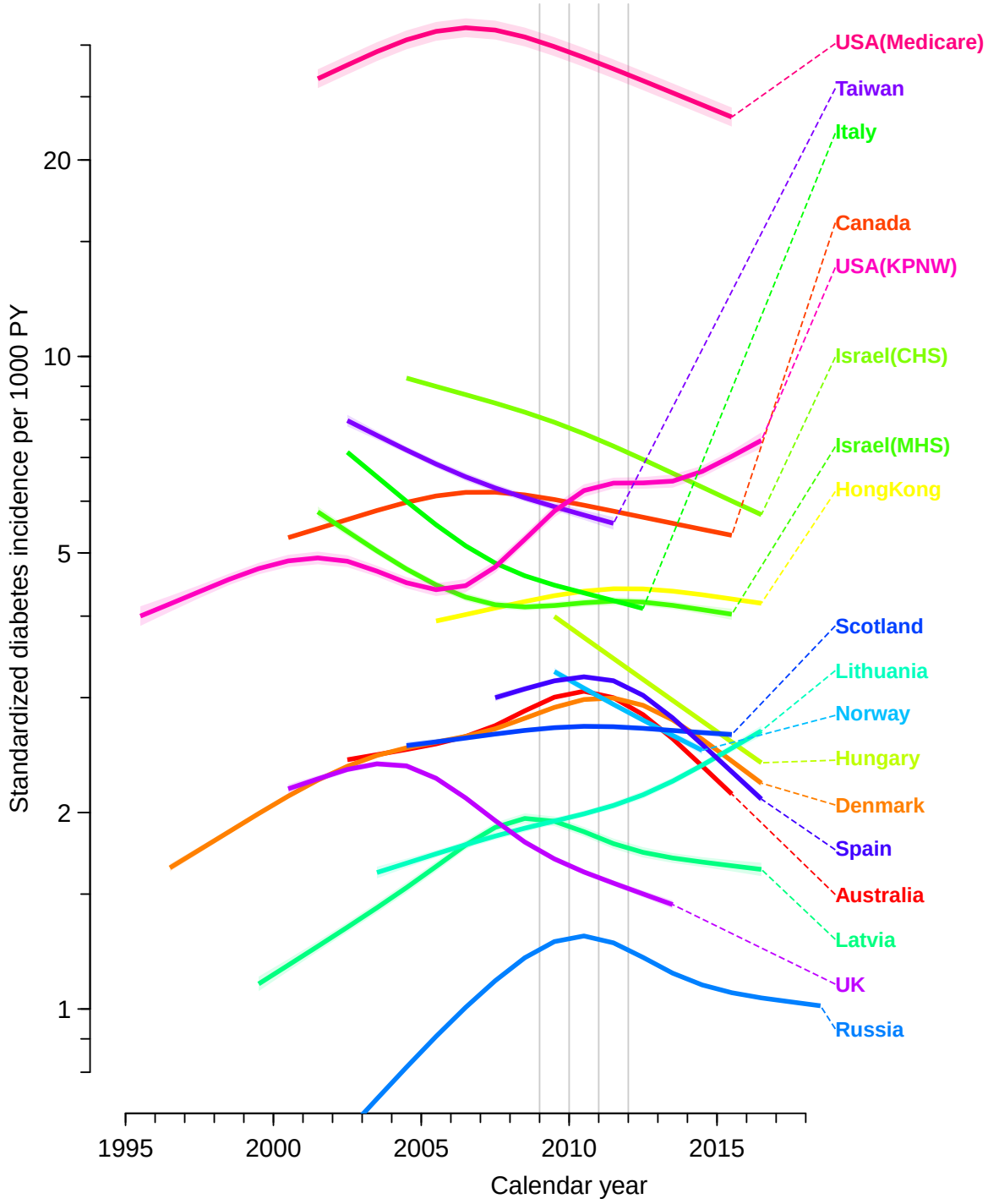

Figure A 13: *Age and sex standardized diabetes incidence rates by data source, for data sources with high quality data.*

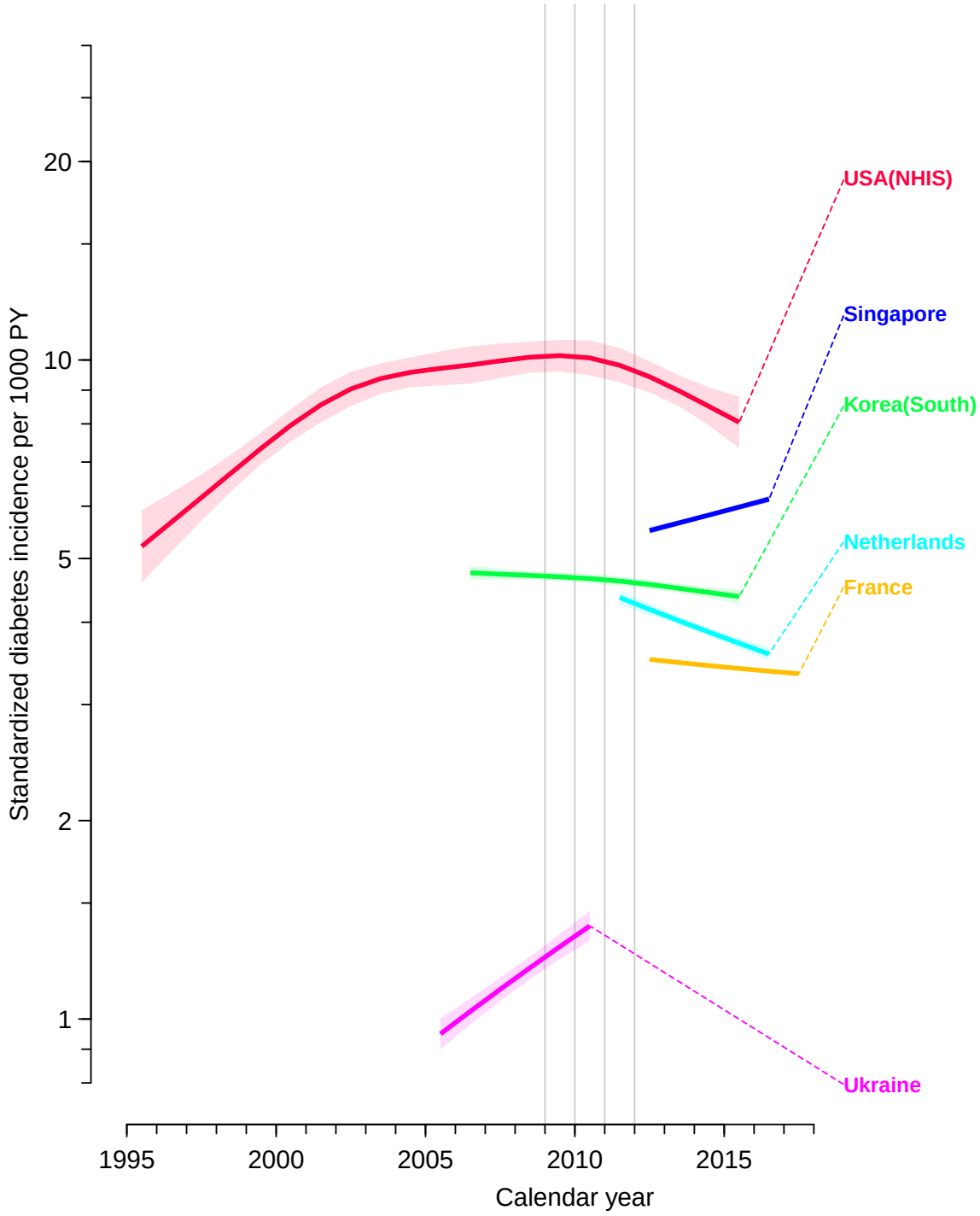

Figure A 14: *Age and sex standardized diabetes incidence rates by data source, for data sources with lower quality data.*

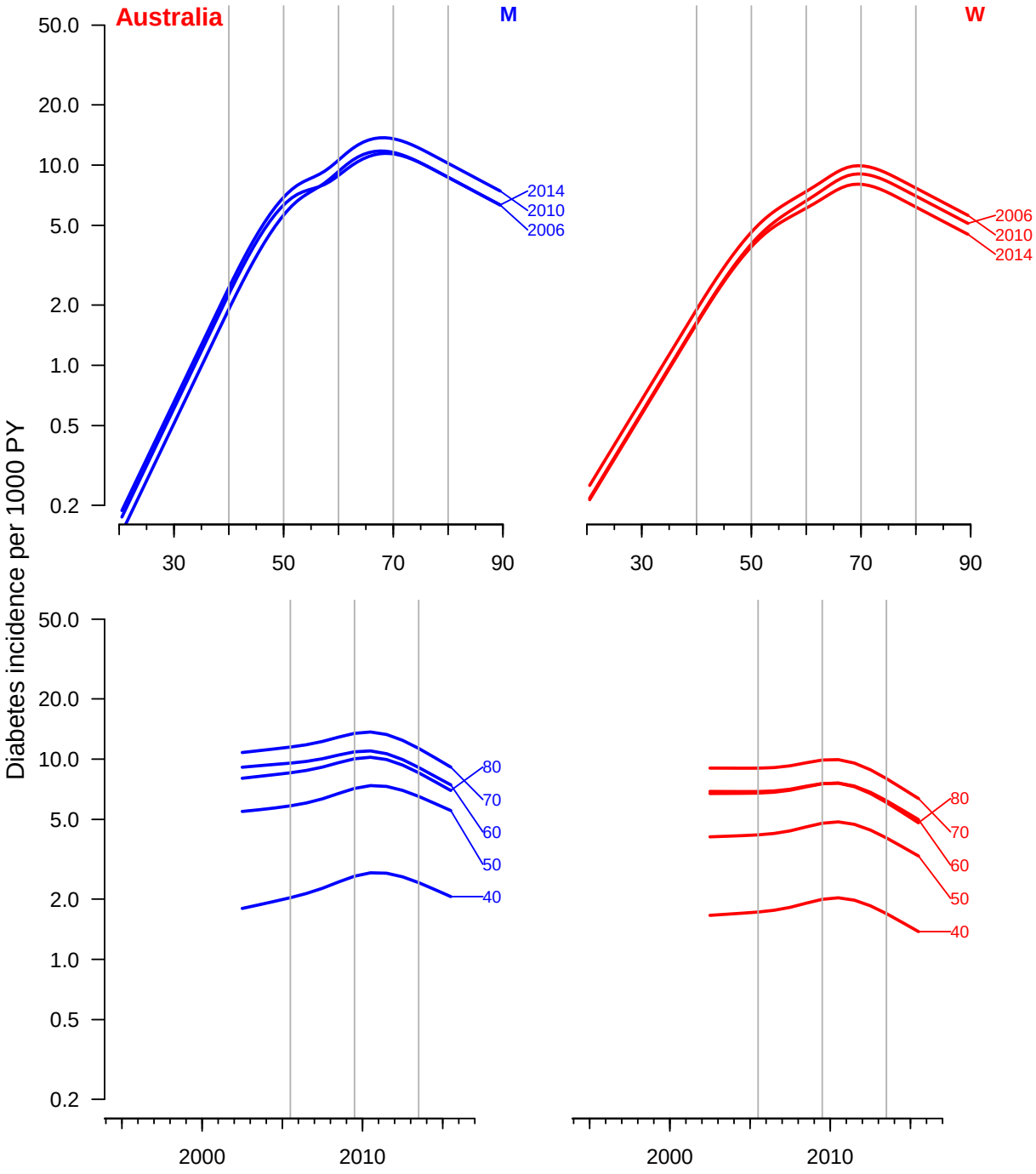

Figure A15: *Estimated incidence rates of diabetes by age and period in Australia. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

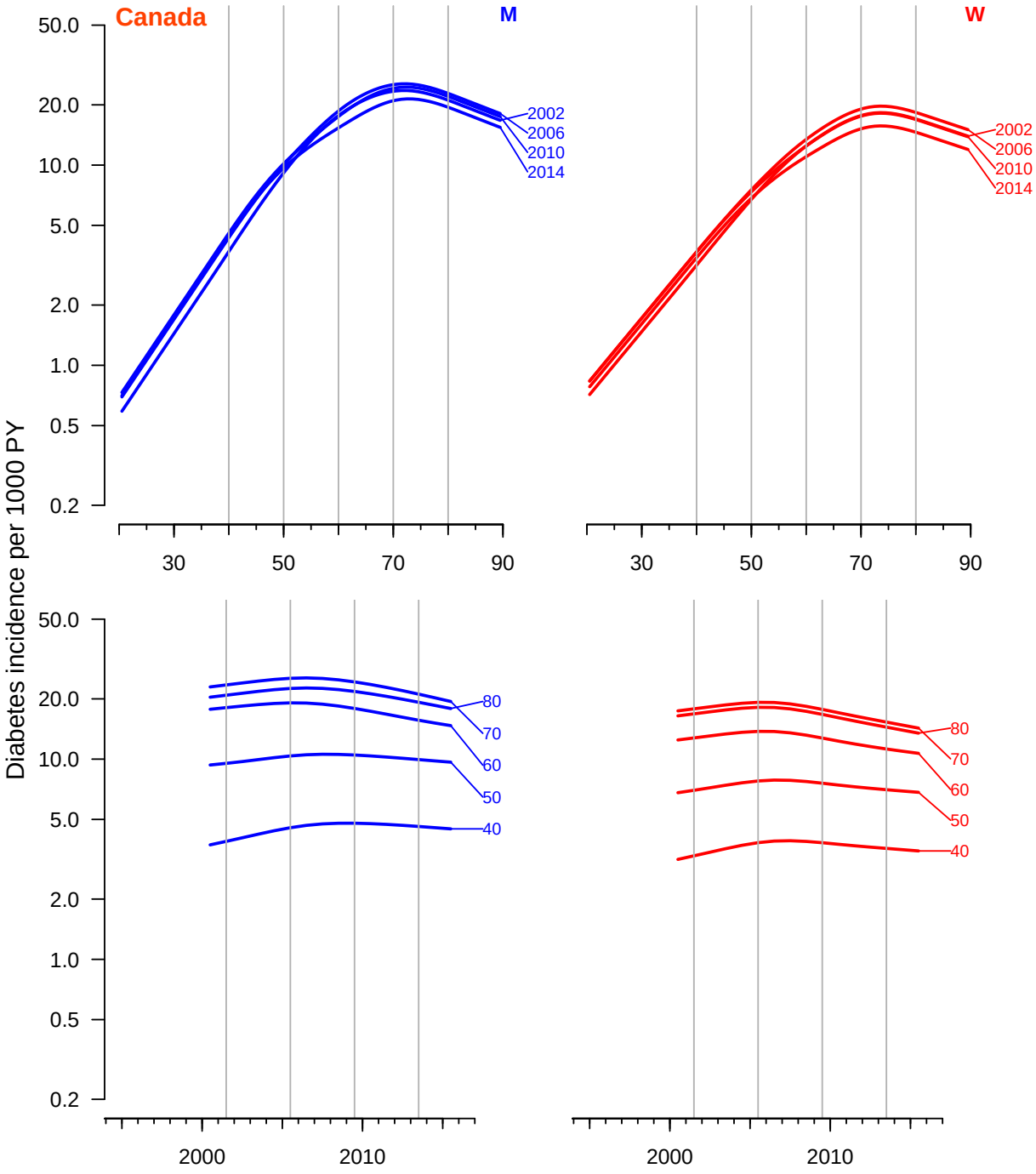

Figure A16: *Estimated incidence rates of diabetes by age and period in Canada. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

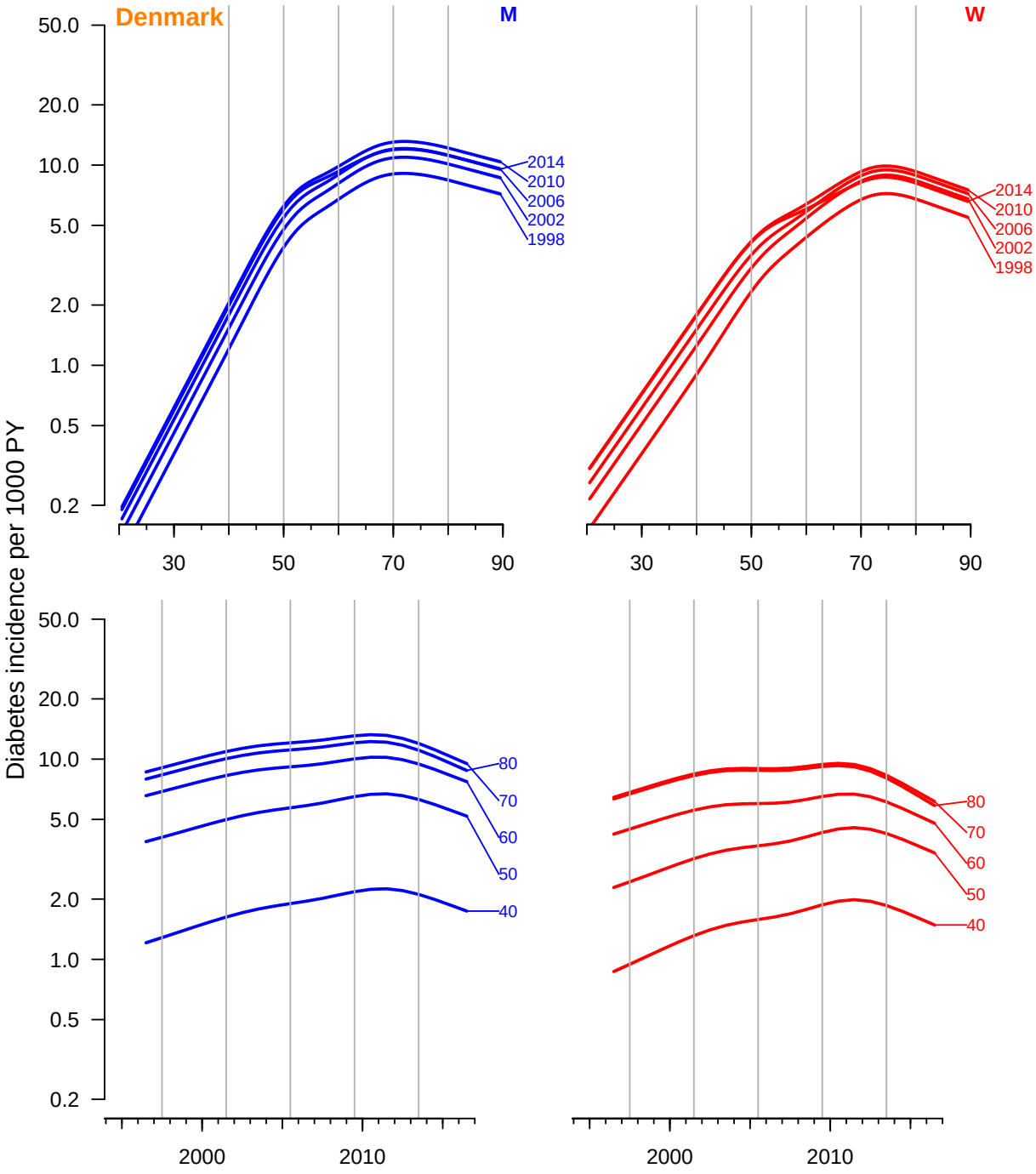

Figure A17: *Estimated incidence rates of diabetes by age and period in Denmark. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

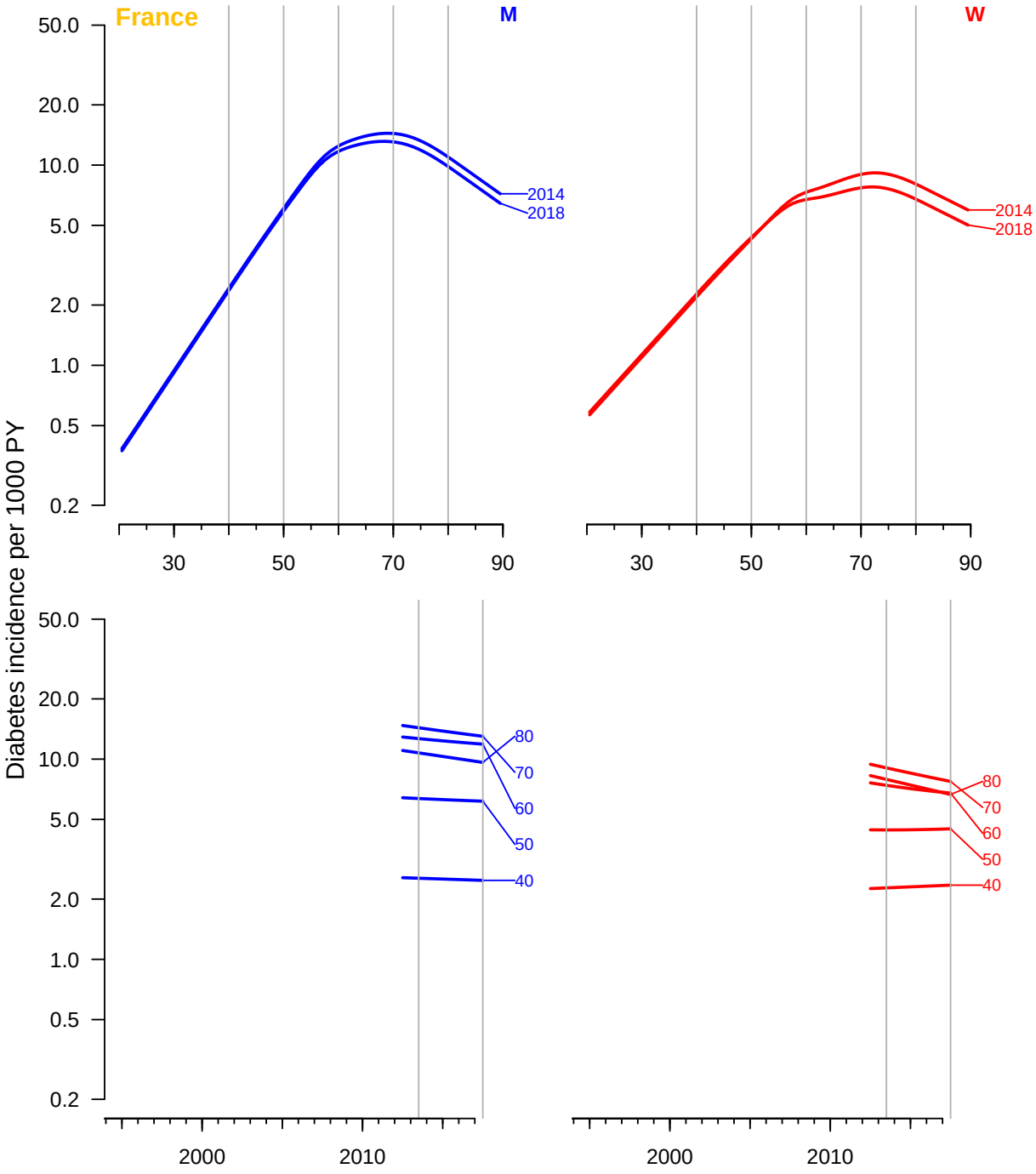

Figure A18: *Estimated incidence rates of diabetes by age and period in France. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

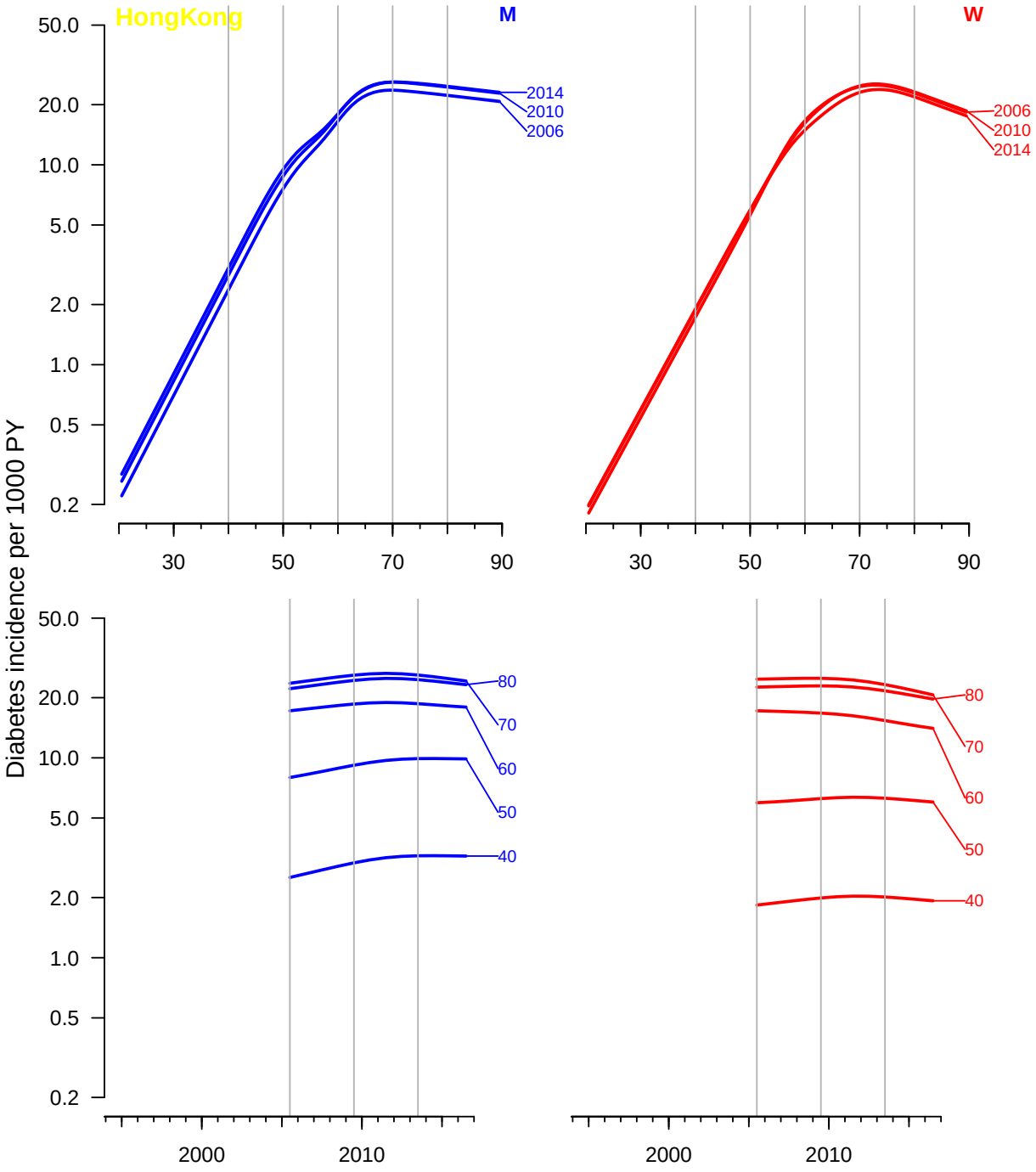

Figure A19: *Estimated incidence rates of diabetes by age and period in HongKong. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

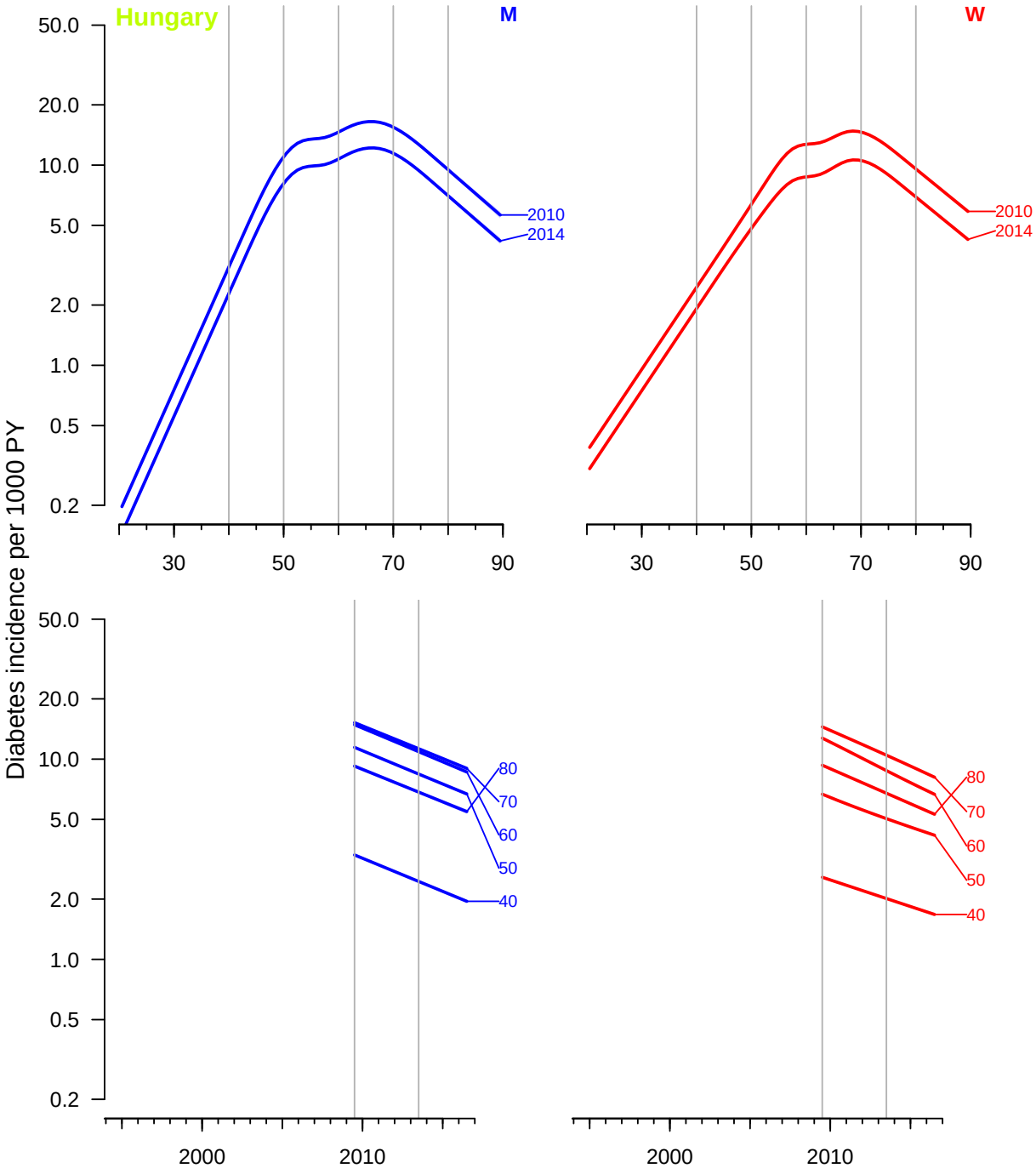

Figure A20: *Estimated incidence rates of diabetes by age and period in Hungary. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

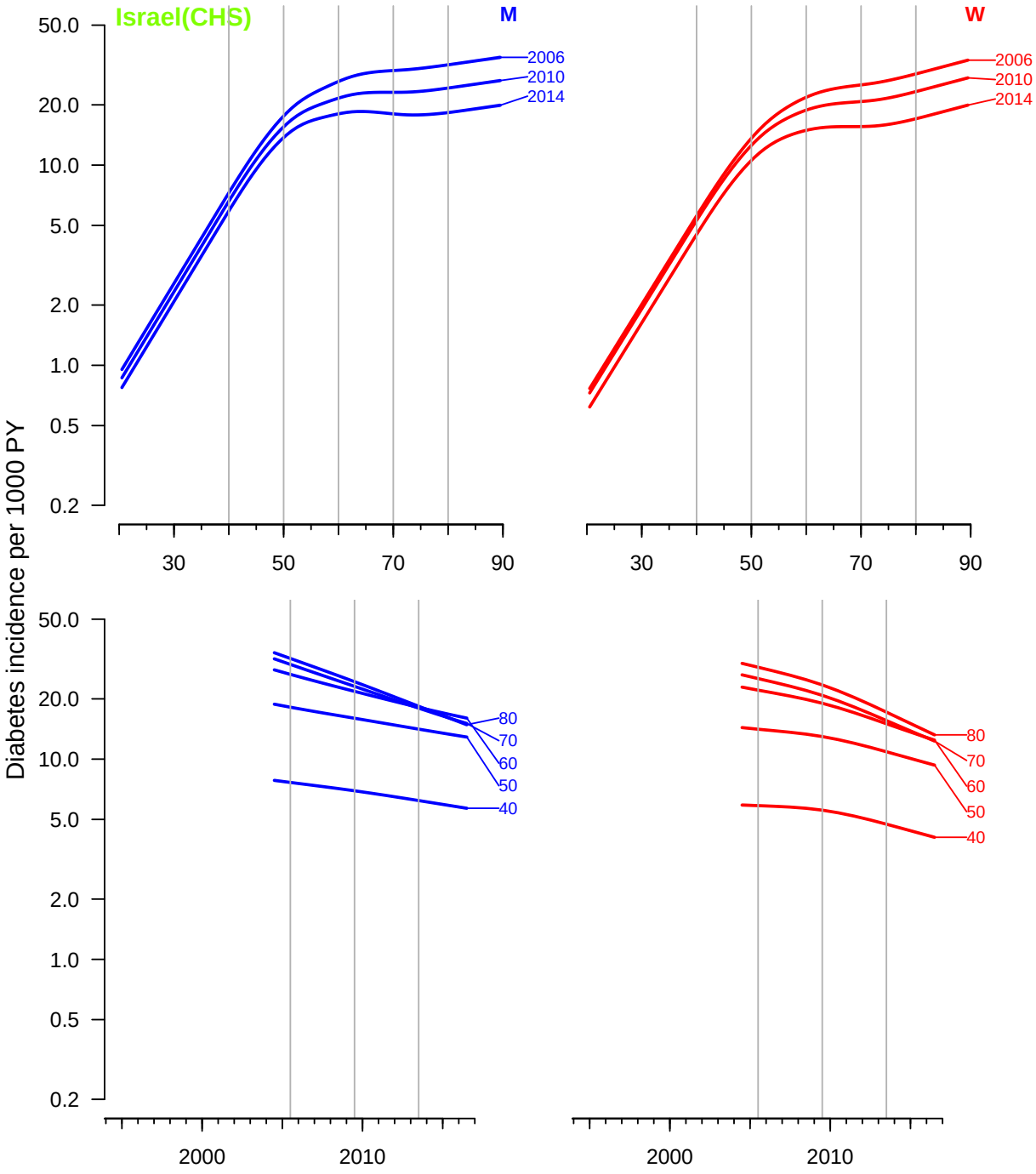

Figure A21: *Estimated incidence rates of diabetes by age and period in Israel(CHS). Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

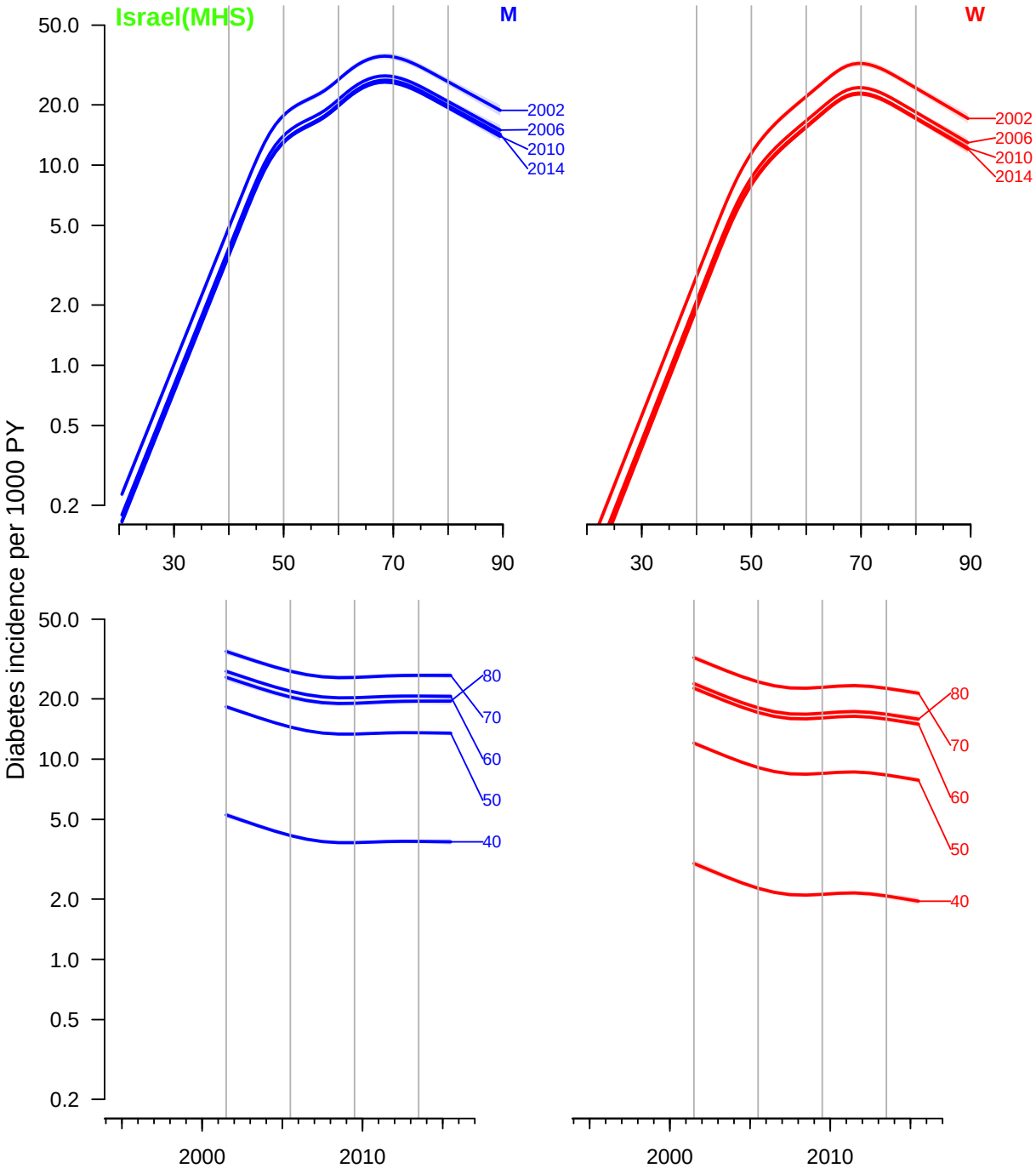

Figure A22: *Estimated incidence rates of diabetes by age and period in Israel(MHS). Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

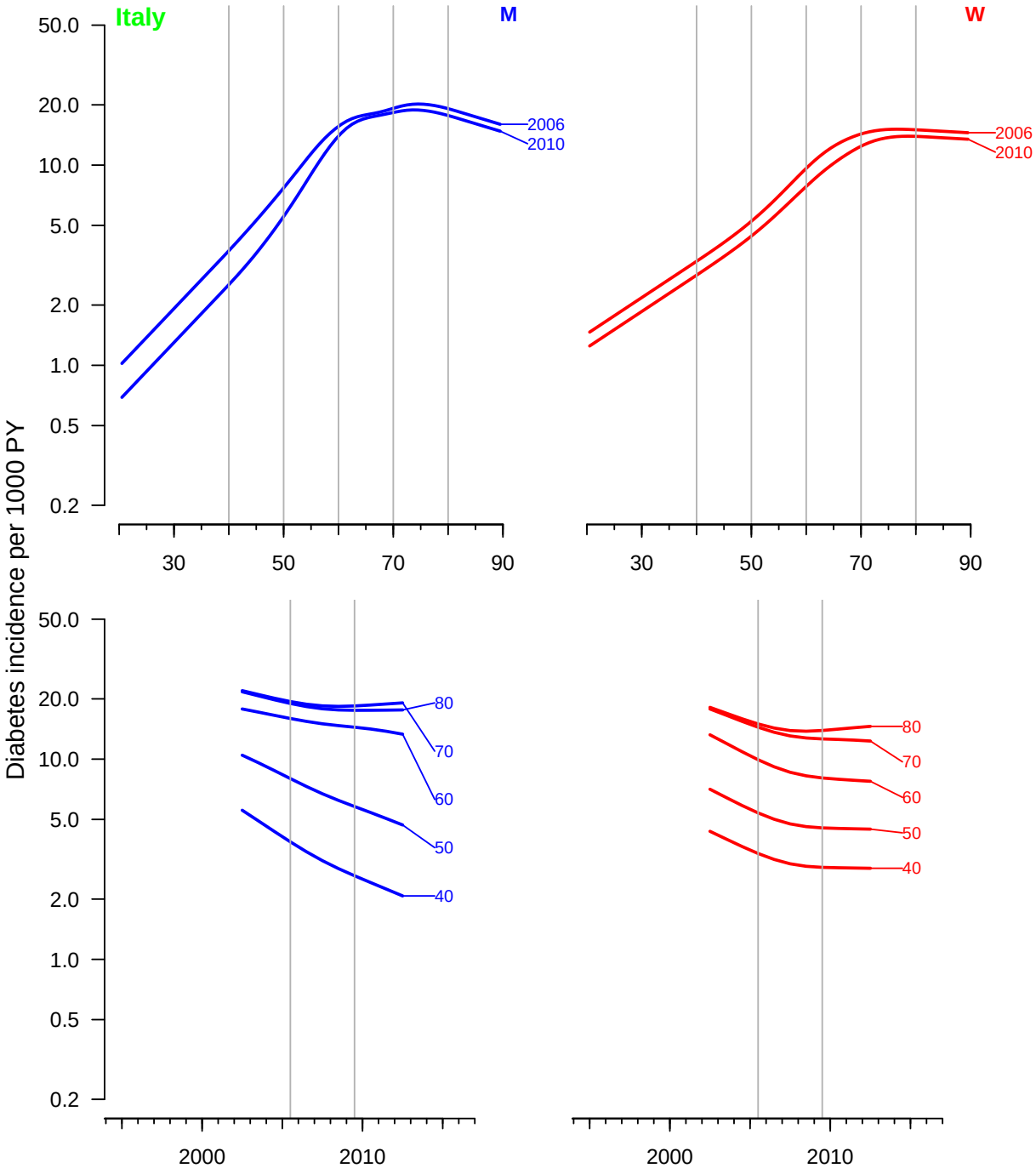

Figure A 23: *Estimated incidence rates of diabetes by age and period in Italy. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

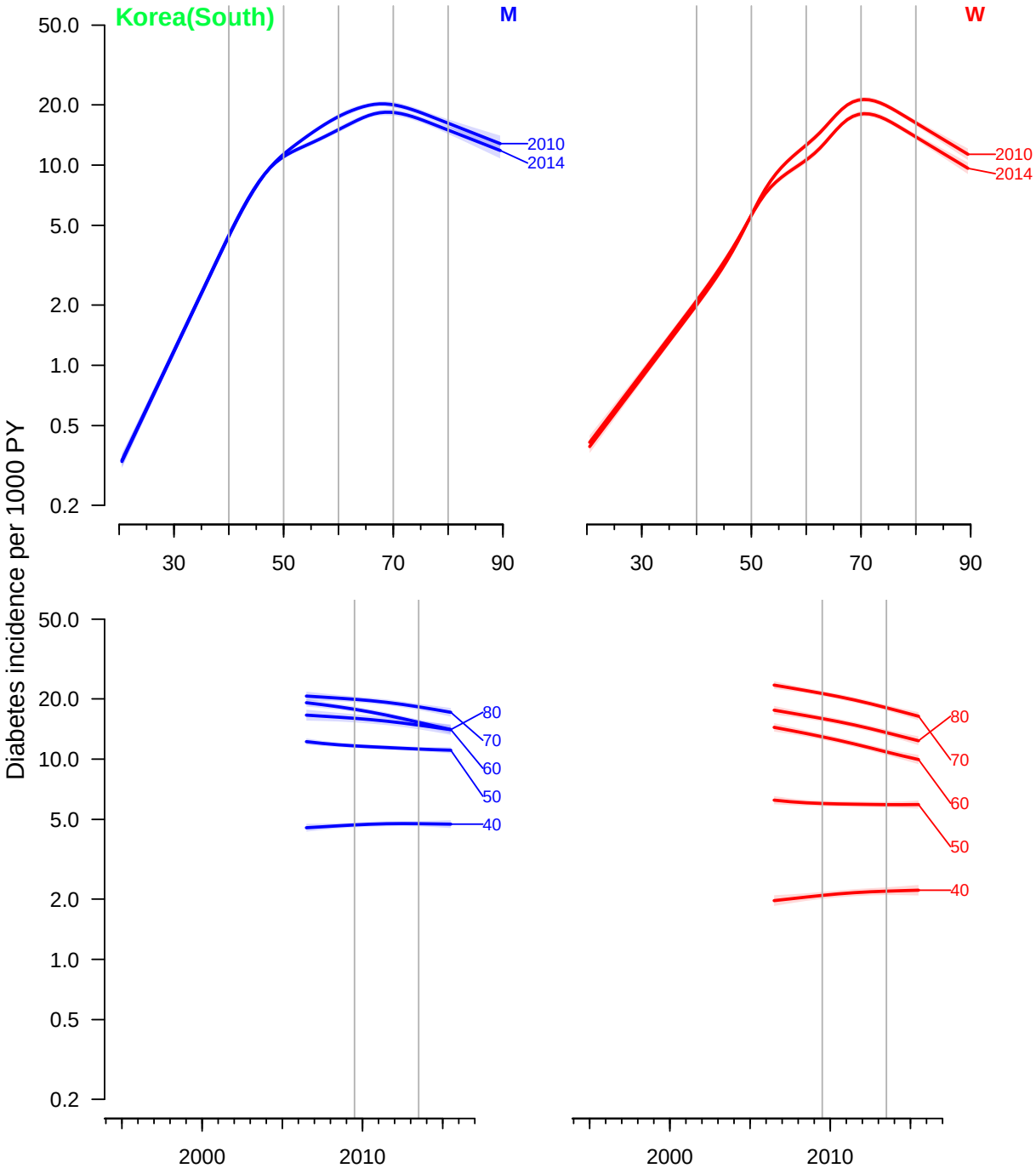

Figure A24: *Estimated incidence rates of diabetes by age and period in Korea(South). Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

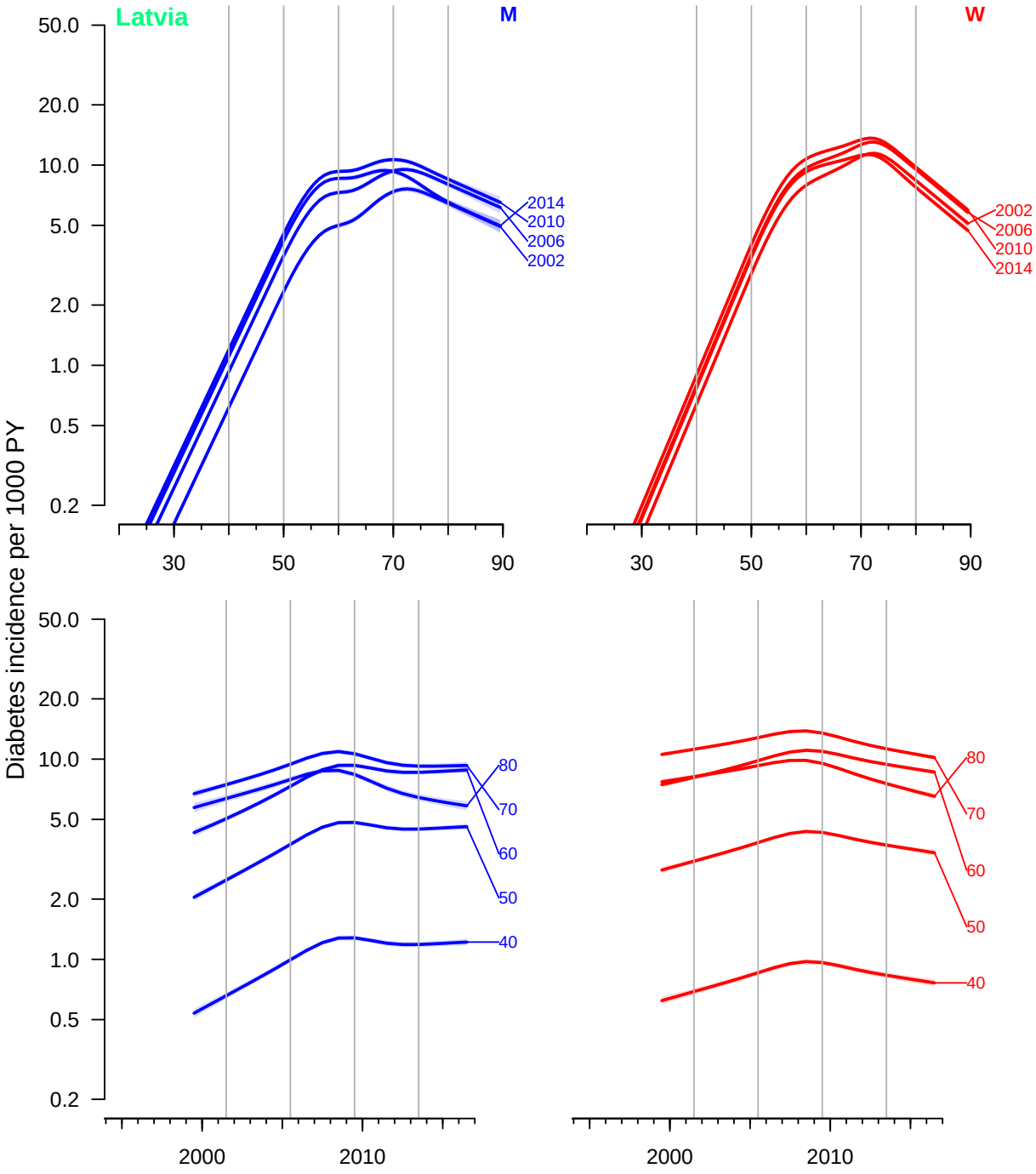

Figure A25: *Estimated incidence rates of diabetes by age and period in Latvia. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

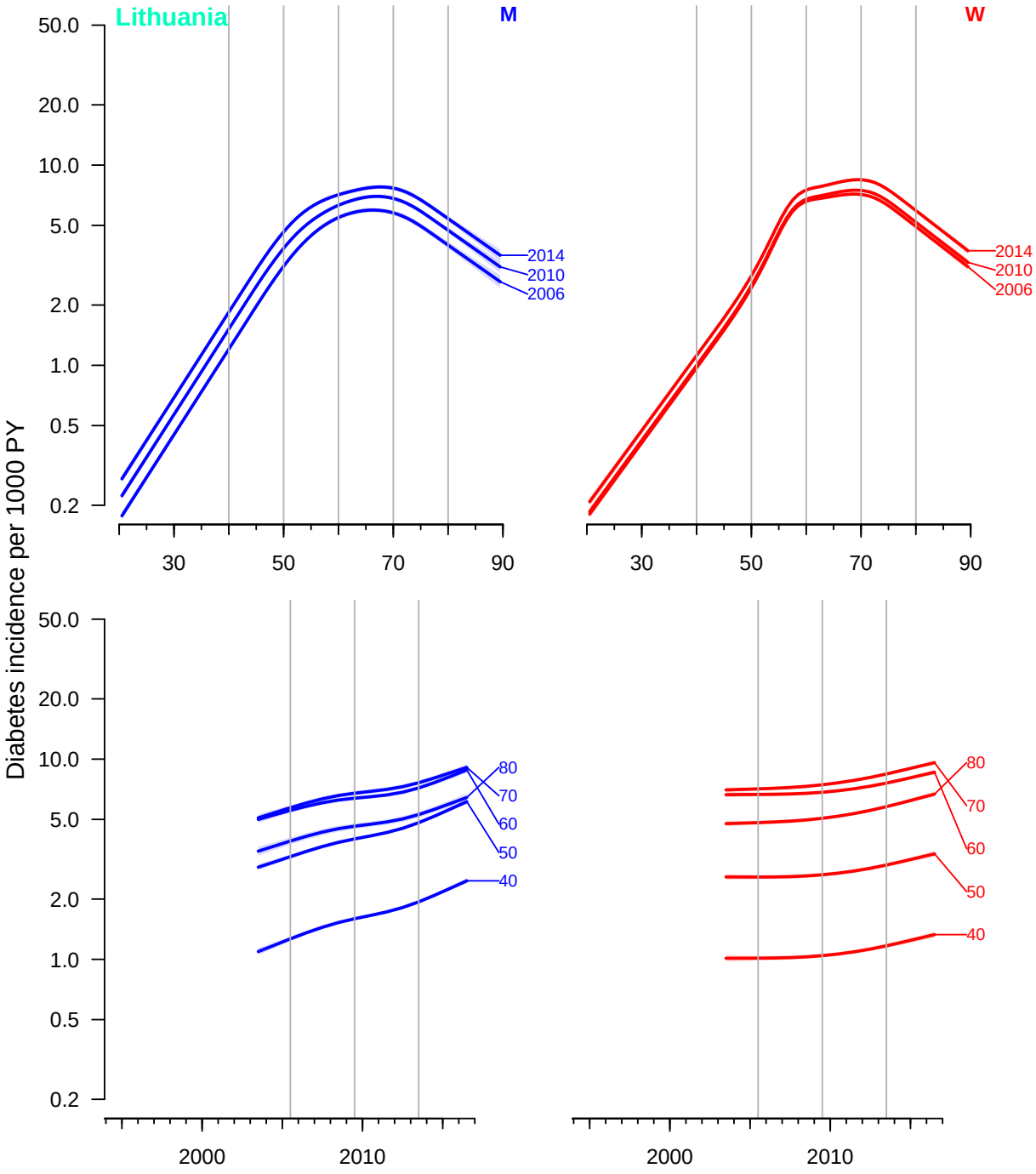

Figure A26: *Estimated incidence rates of diabetes by age and period in Lithuania. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

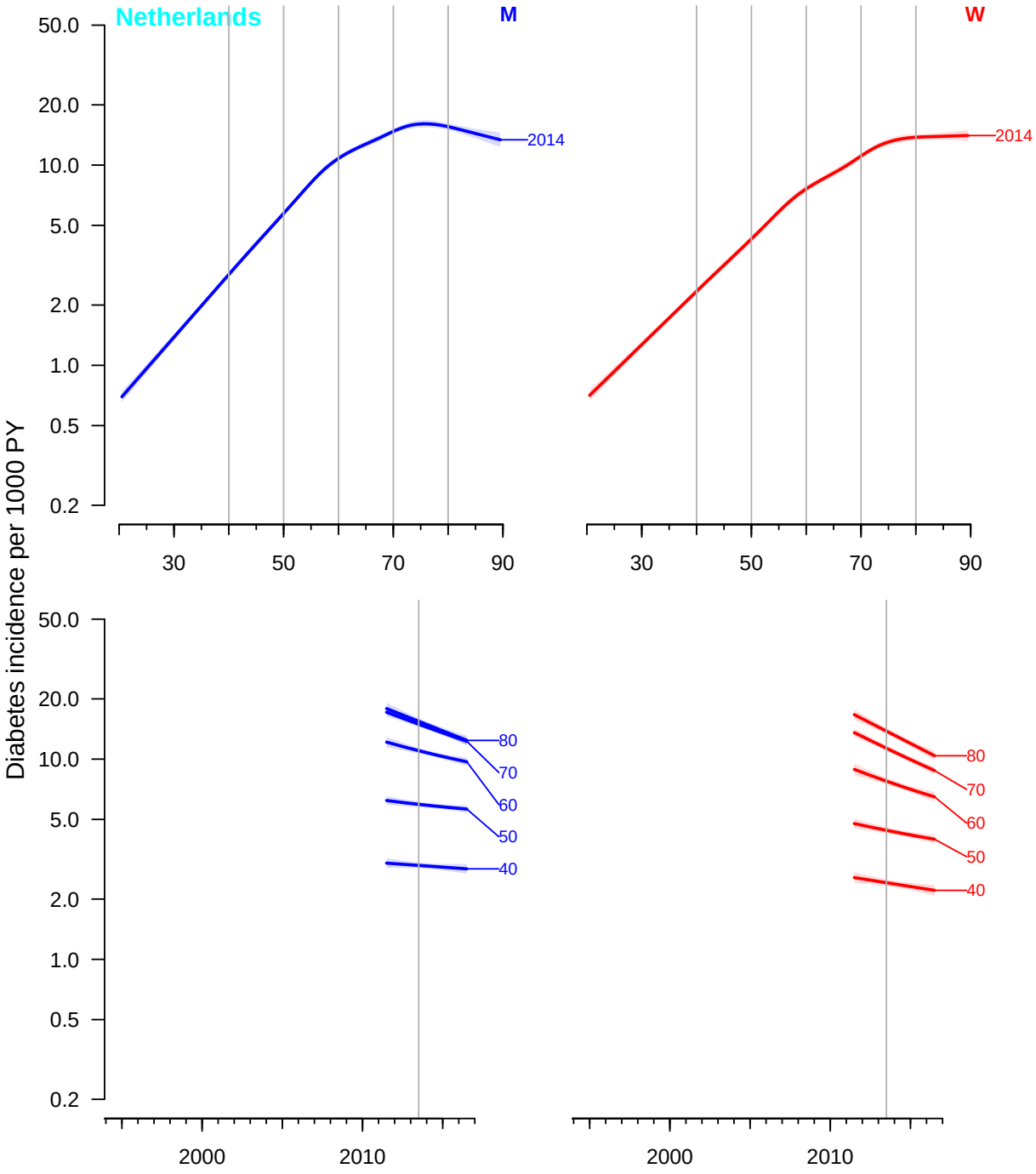

Figure A27: *Estimated incidence rates of diabetes by age and period in Netherlands. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

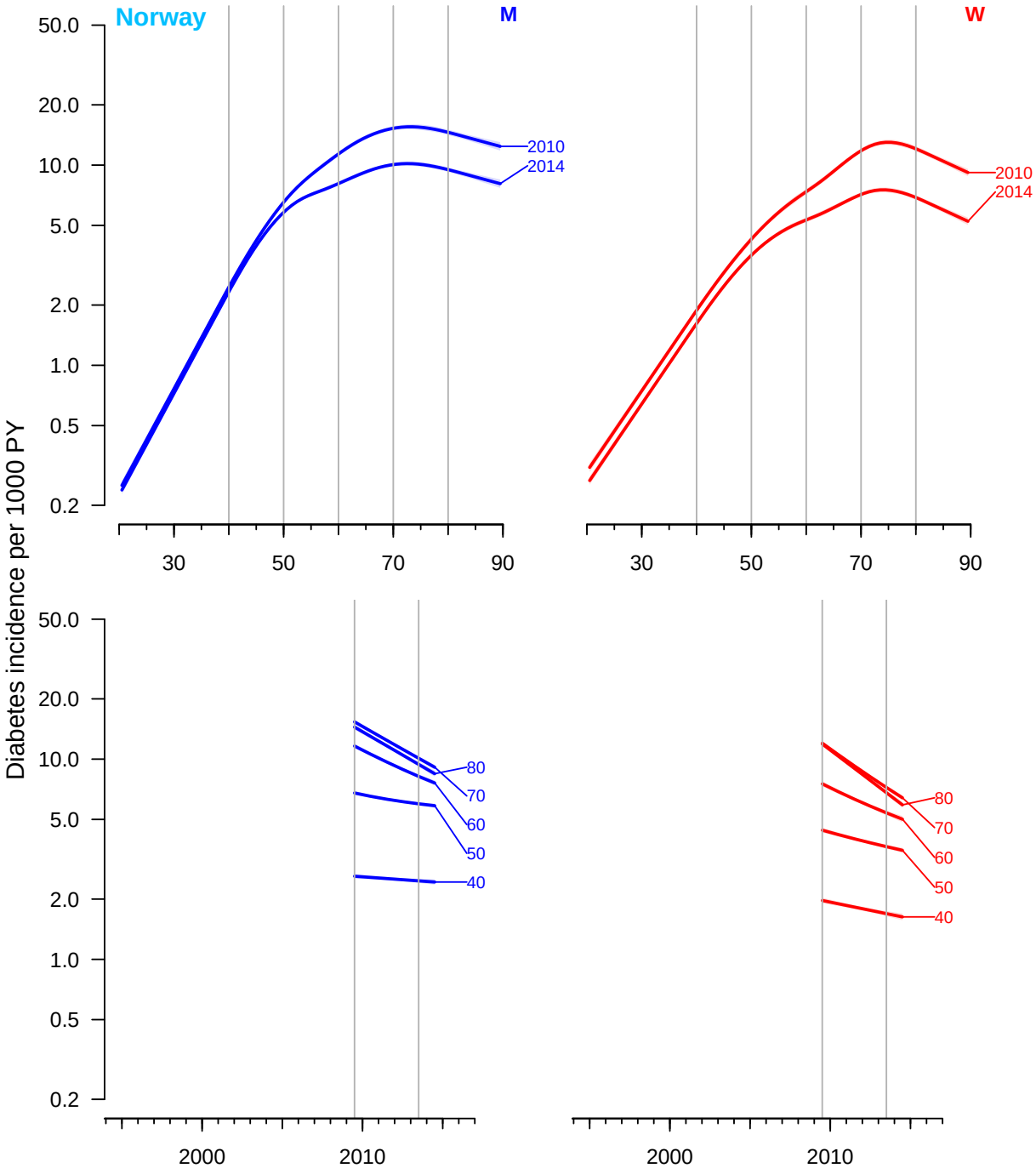

Figure A28: *Estimated incidence rates of diabetes by age and period in Norway. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

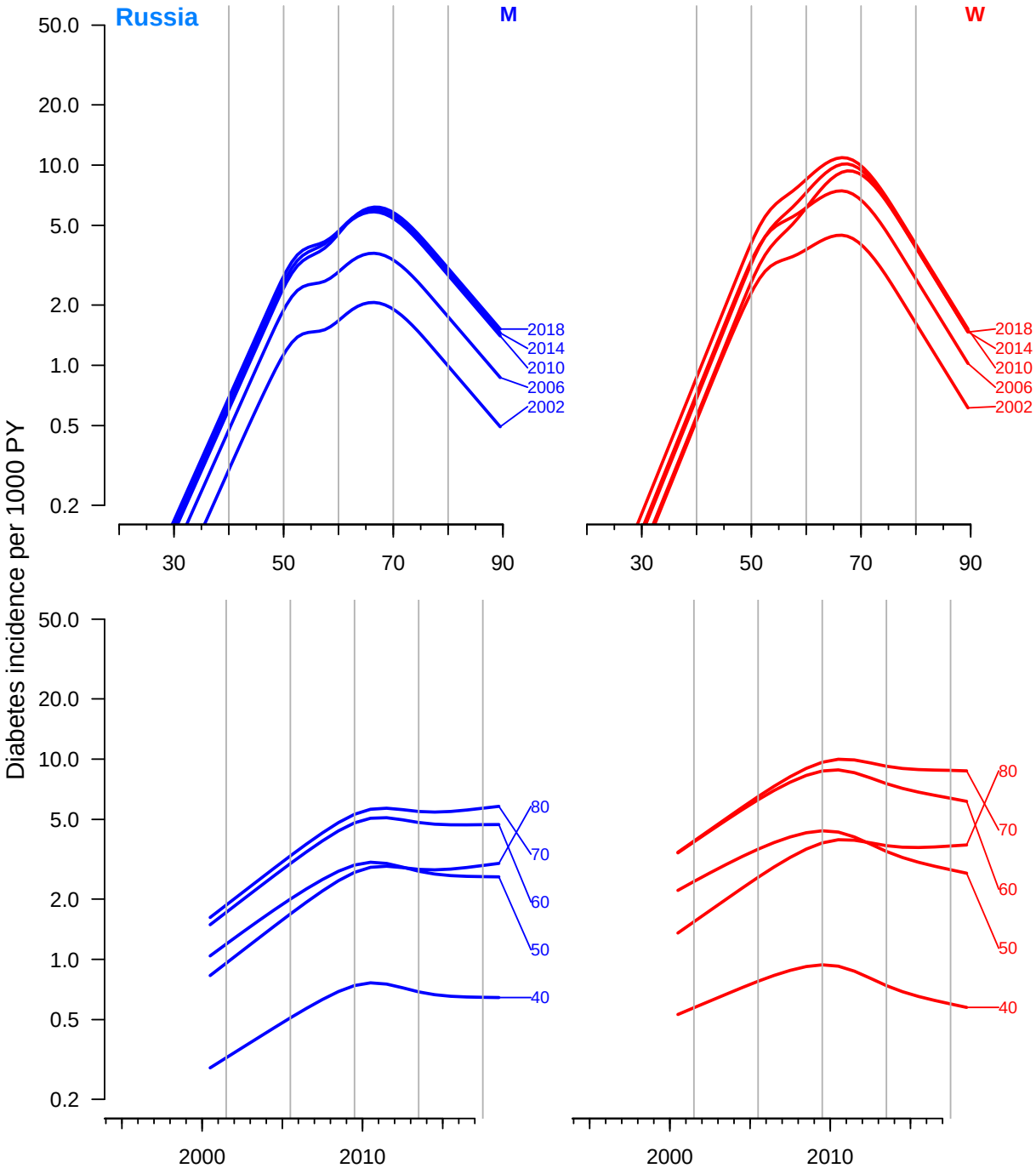

Figure A29: *Estimated incidence rates of diabetes by age and period in Russia. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

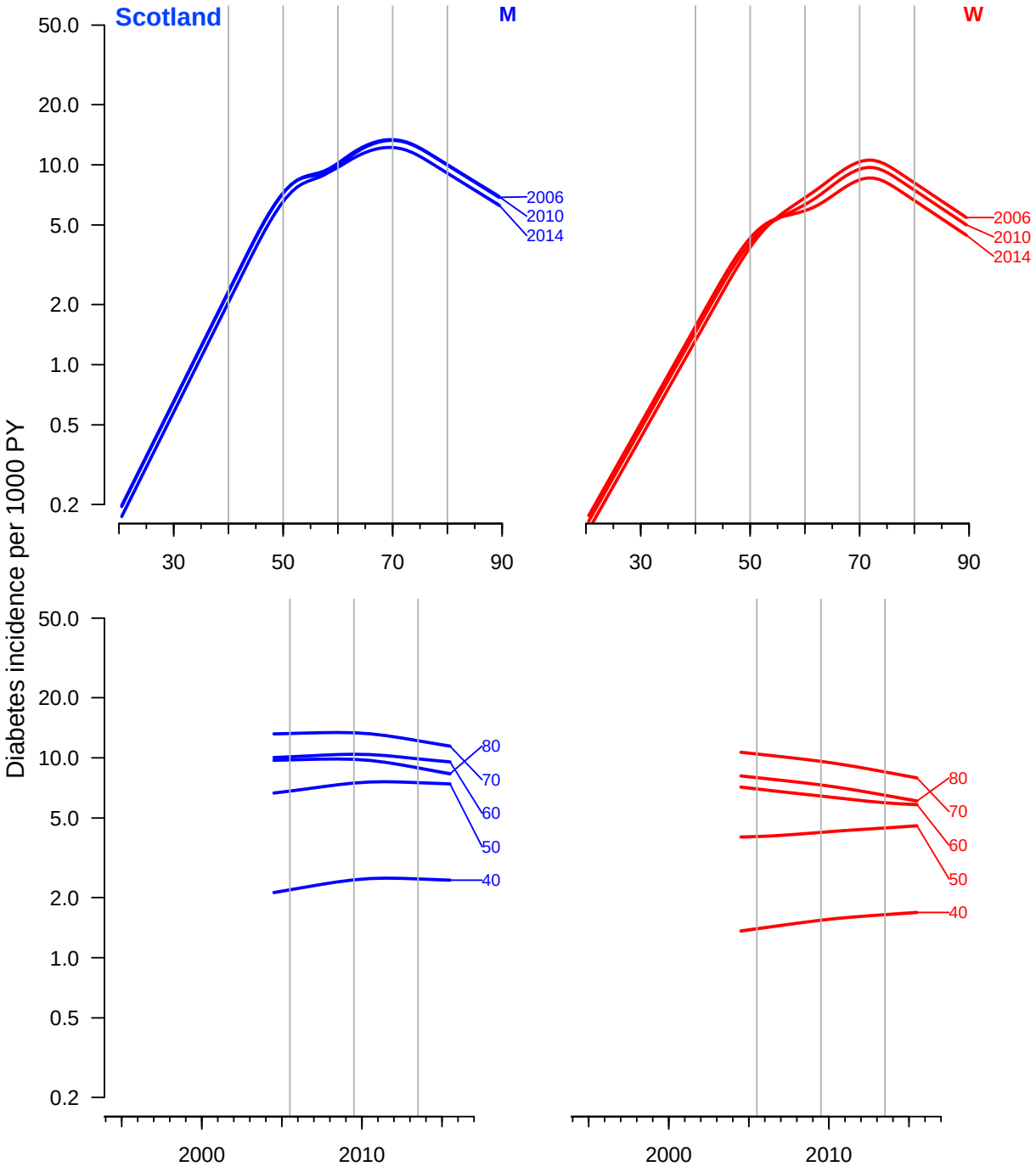

Figure A30: *Estimated incidence rates of diabetes by age and period in Scotland. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

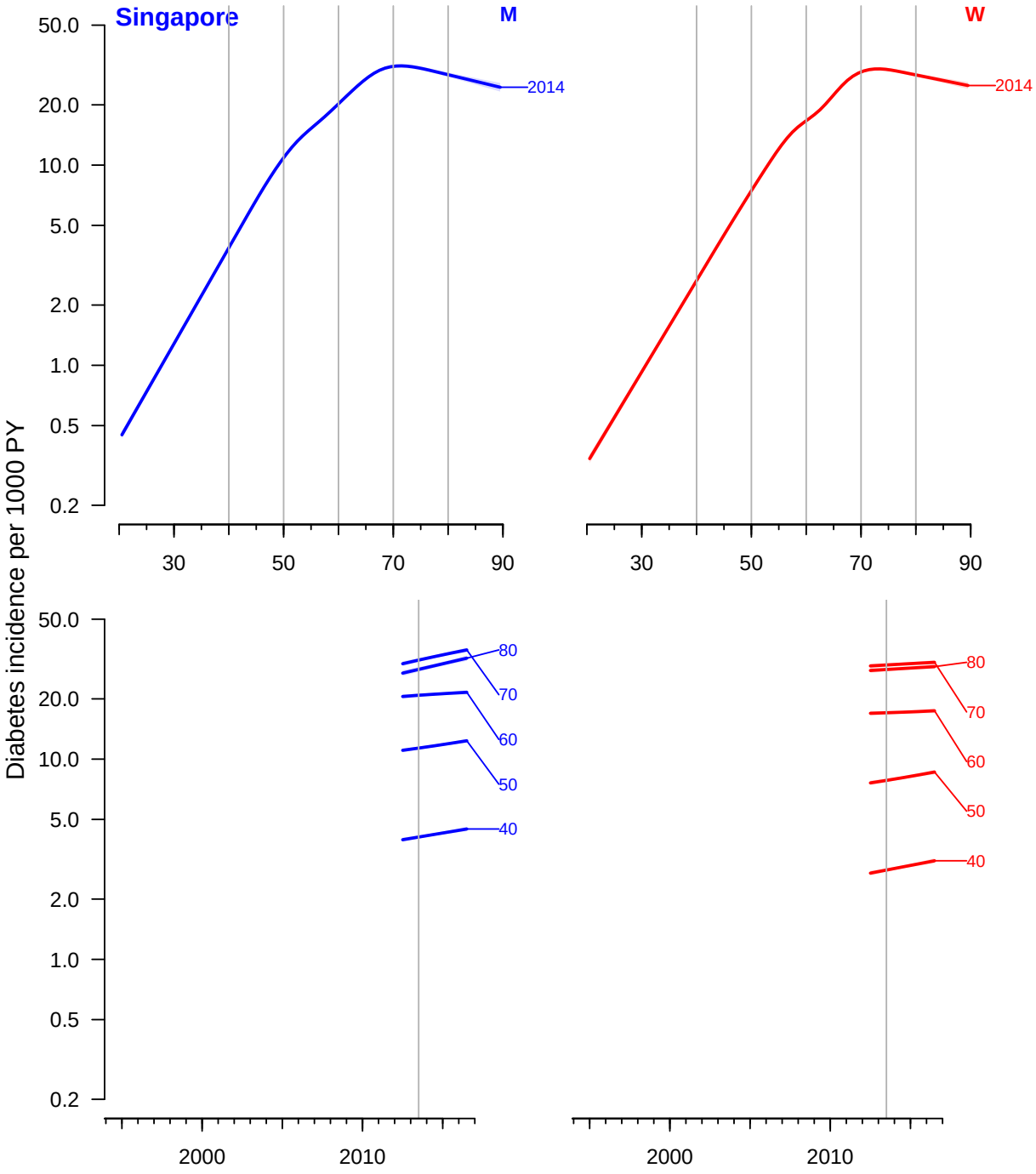

Figure A31: *Estimated incidence rates of diabetes by age and period in Singapore. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

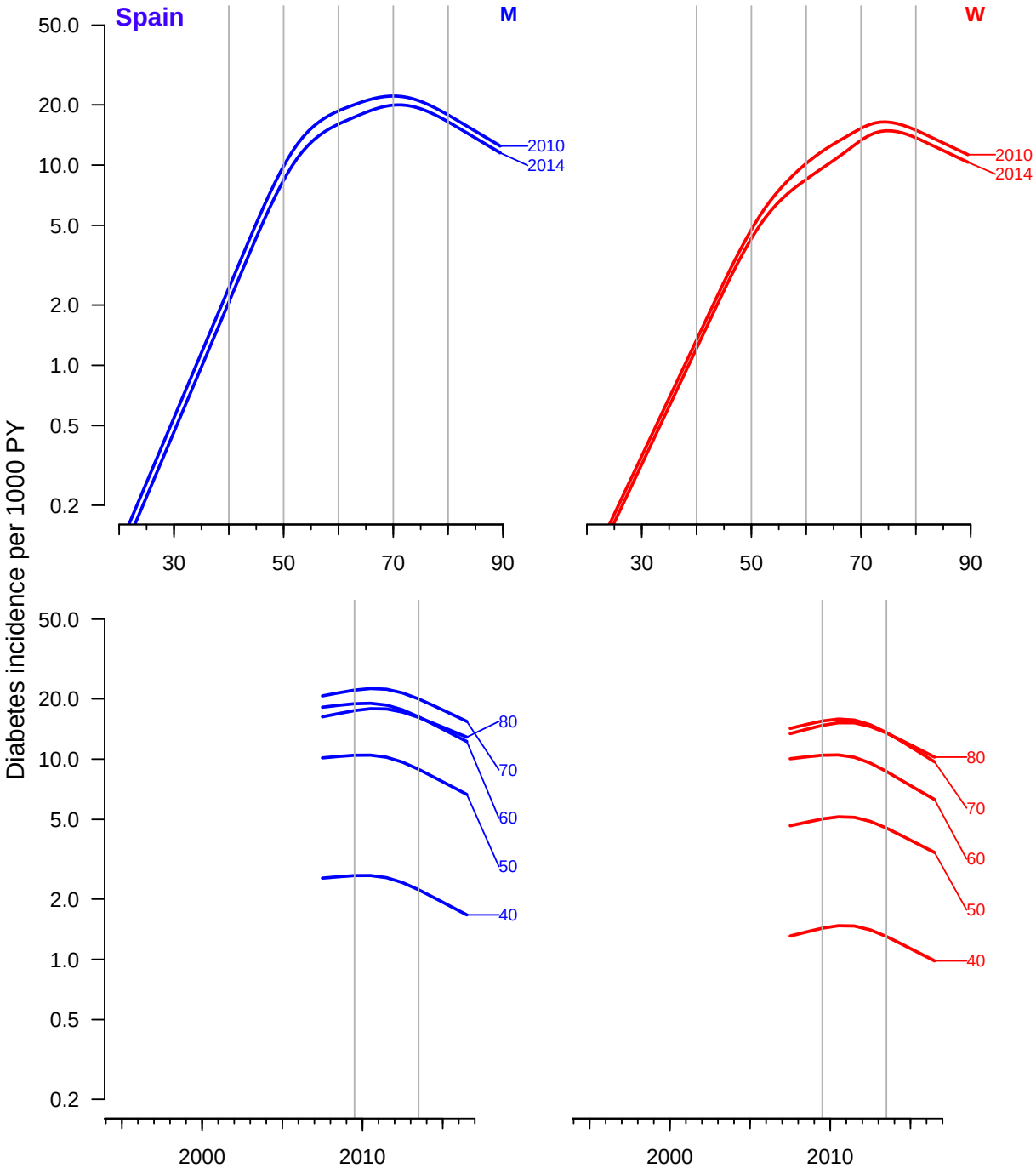

Figure A32: *Estimated incidence rates of diabetes by age and period in Spain. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

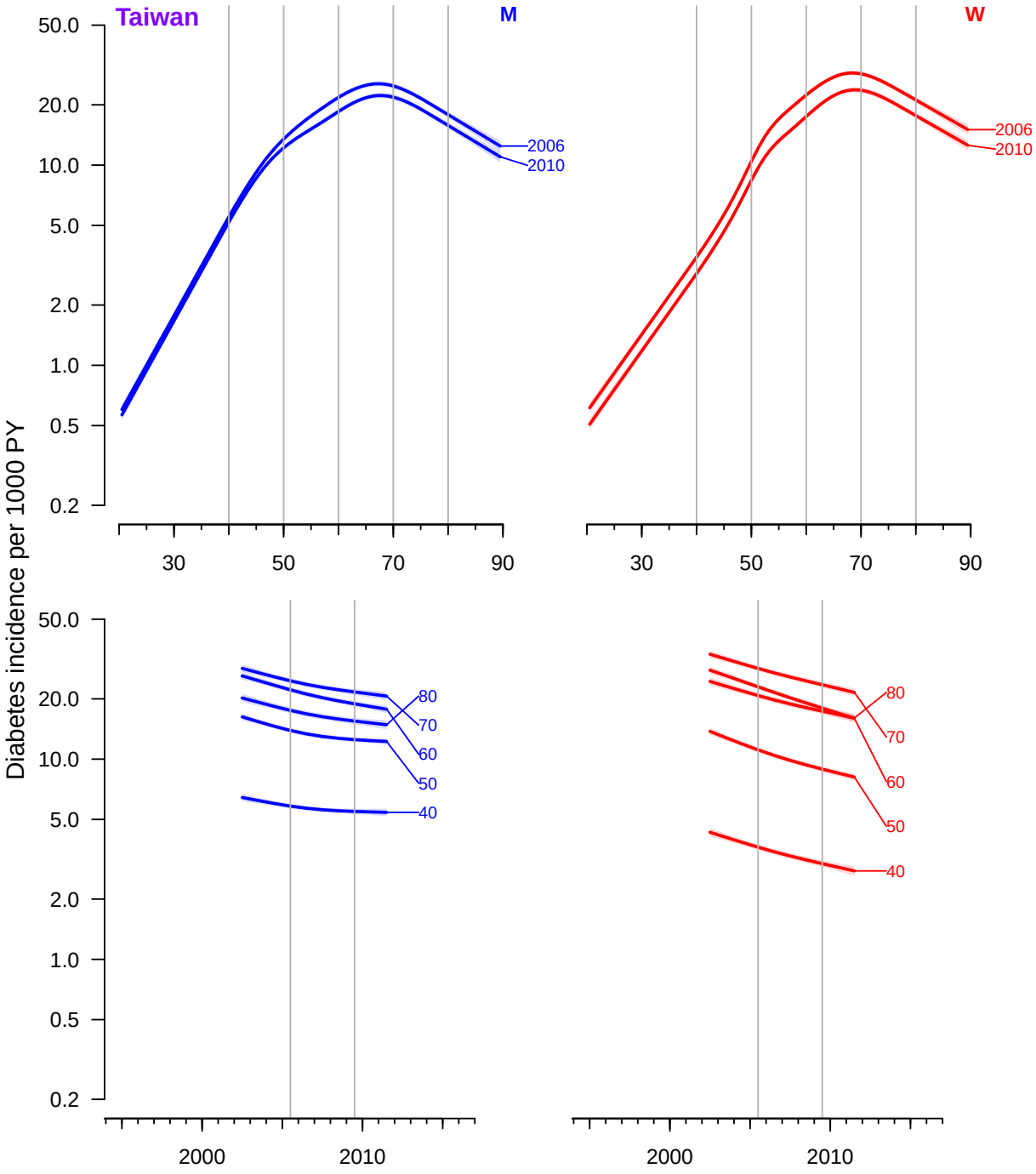

Figure A33: *Estimated incidence rates of diabetes by age and period in Taiwan. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

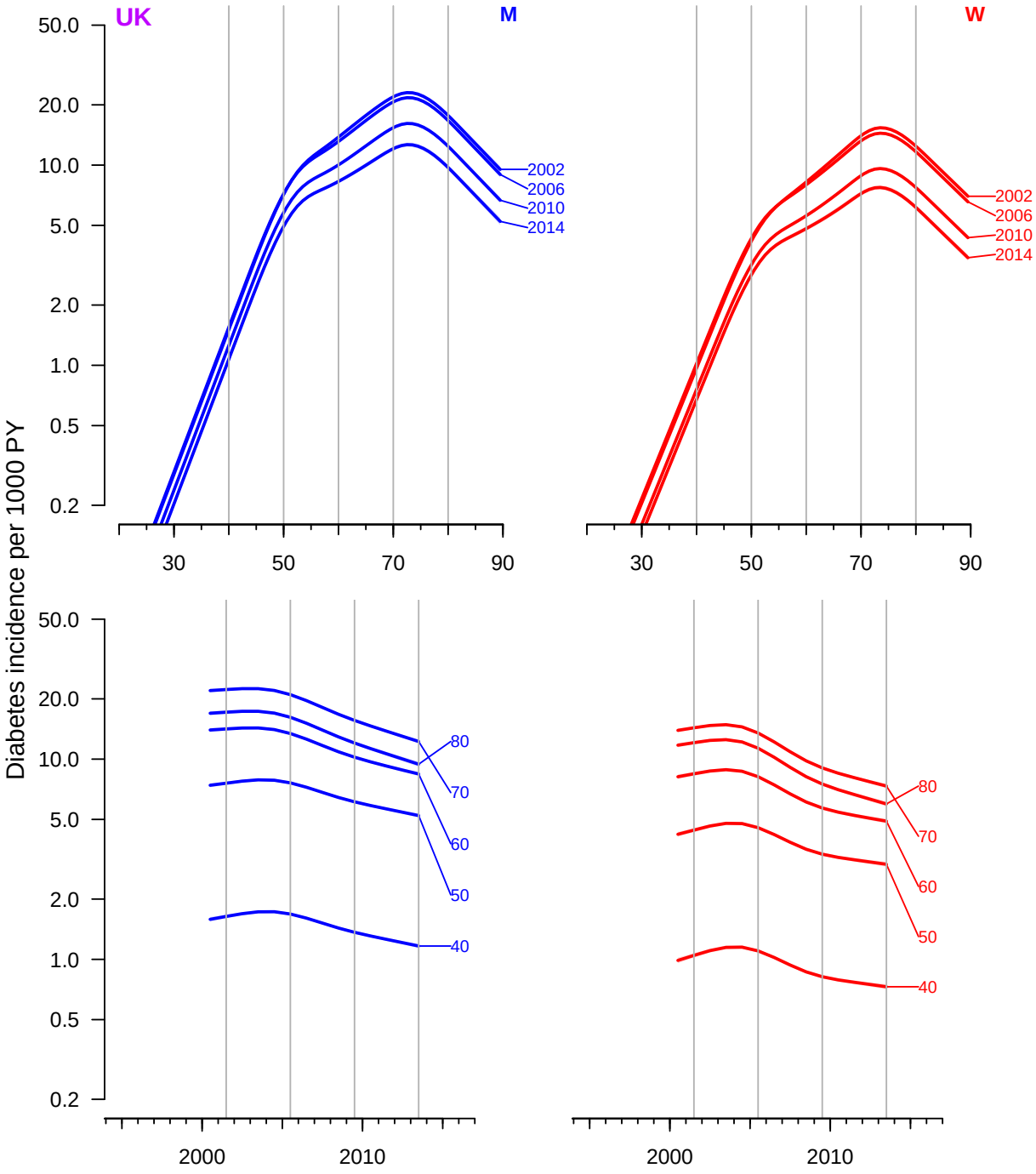

Figure A34: *Estimated incidence rates of diabetes by age and period in UK. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

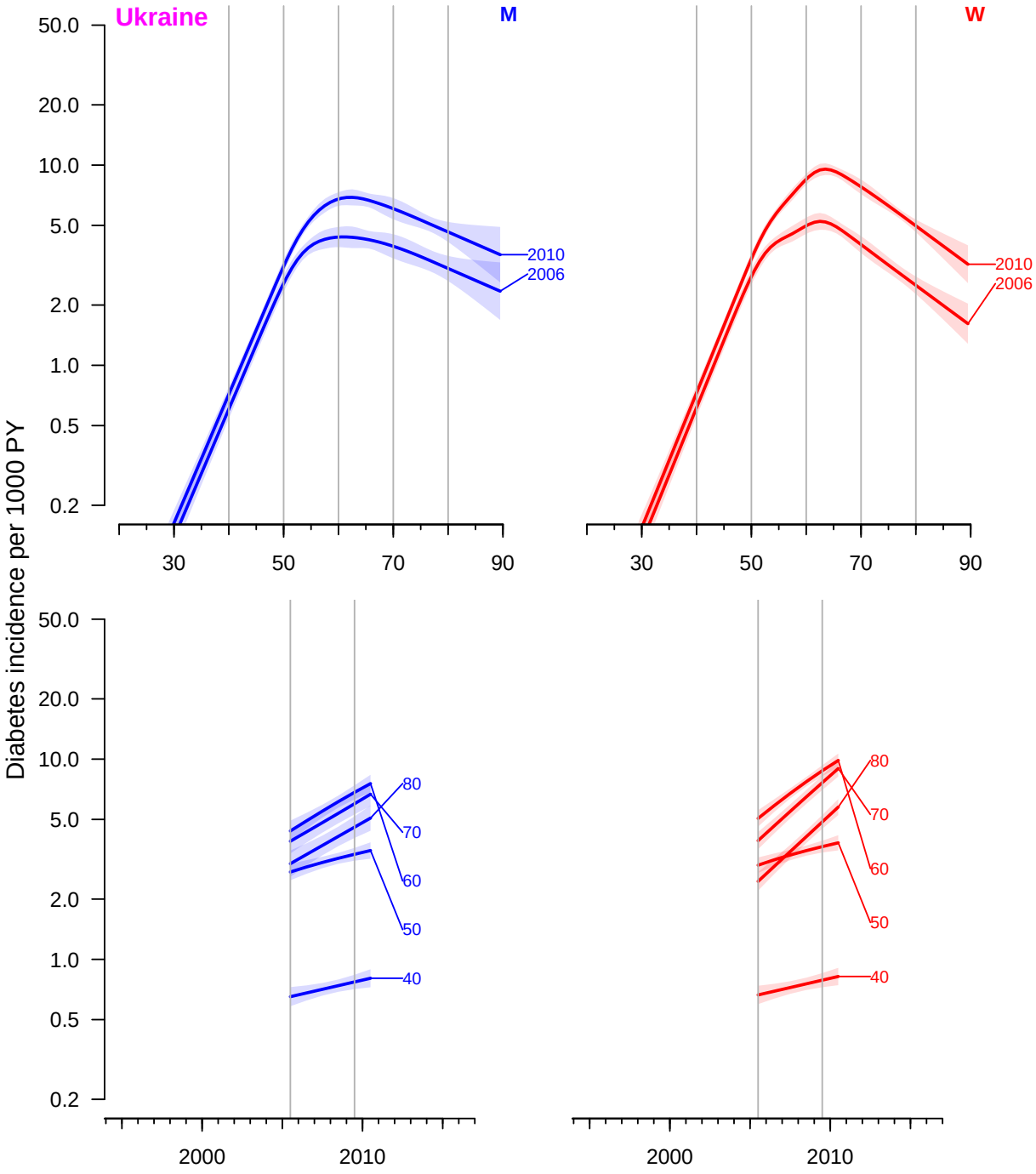

Figure A35: *Estimated incidence rates of diabetes by age and period in Ukraine. Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

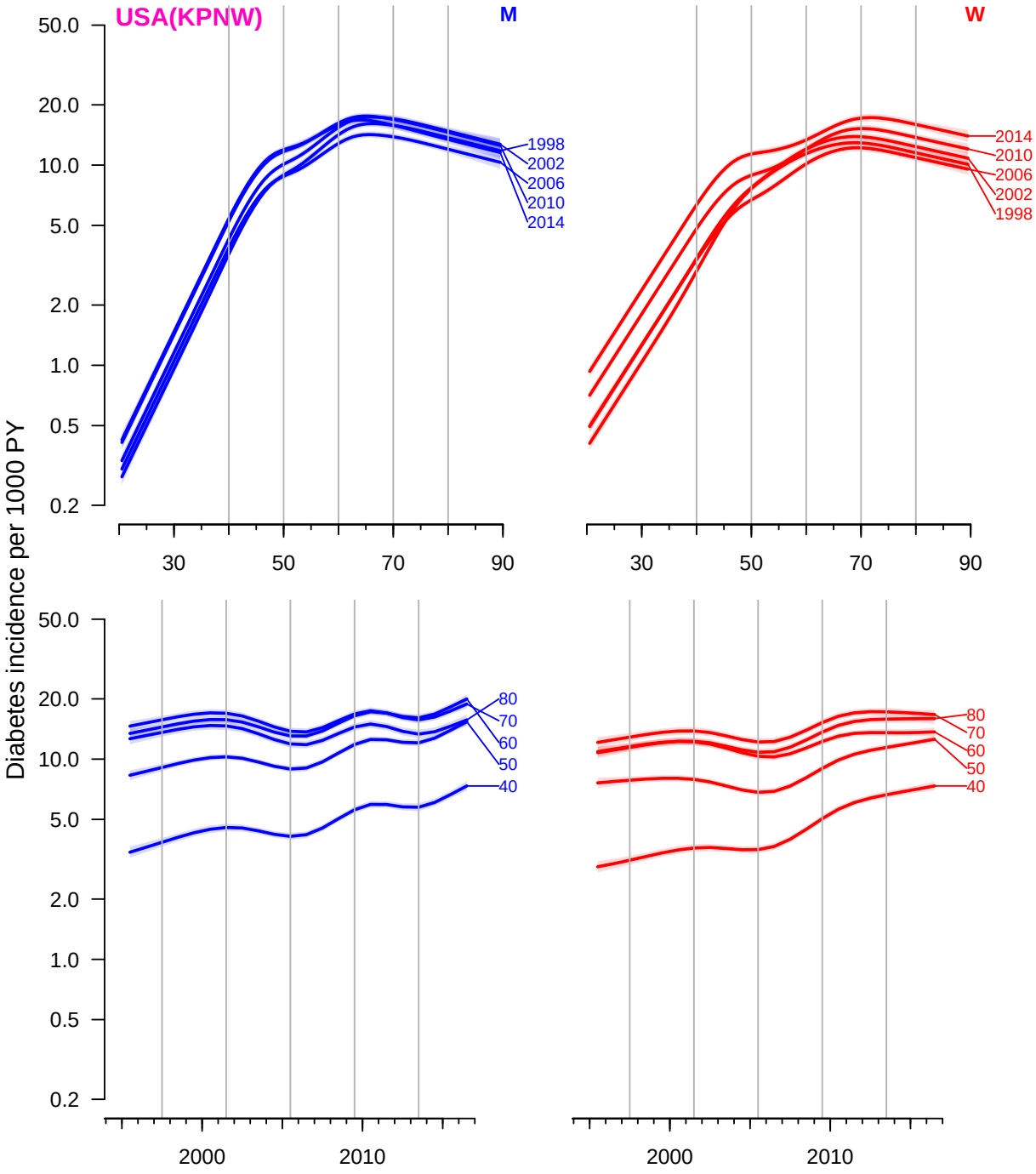

Figure A36: *Estimated incidence rates of diabetes by age and period in USA(KPNW). Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

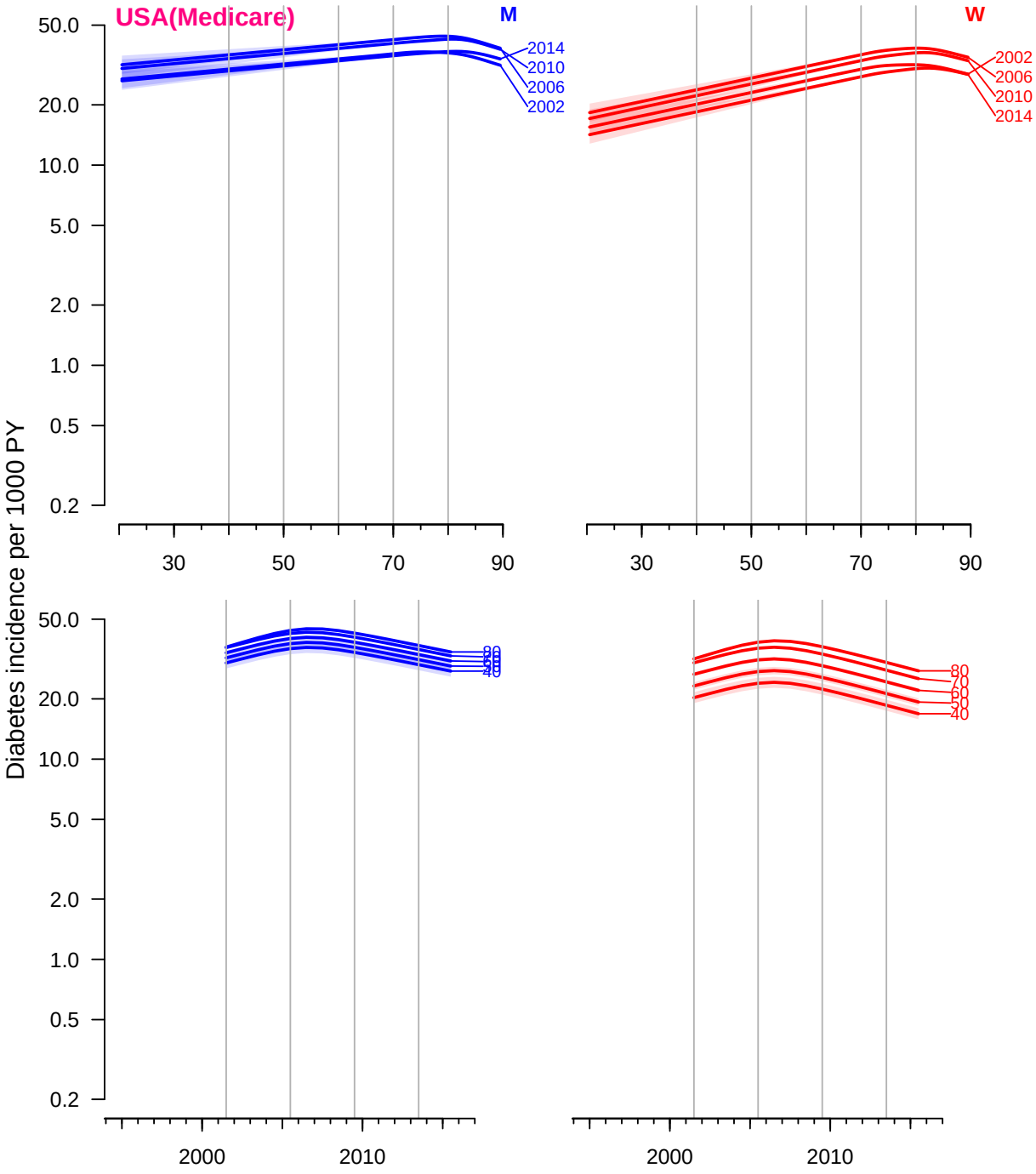

Figure A 37: *Estimated incidence rates of diabetes by age and period in USA(Medicare). Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

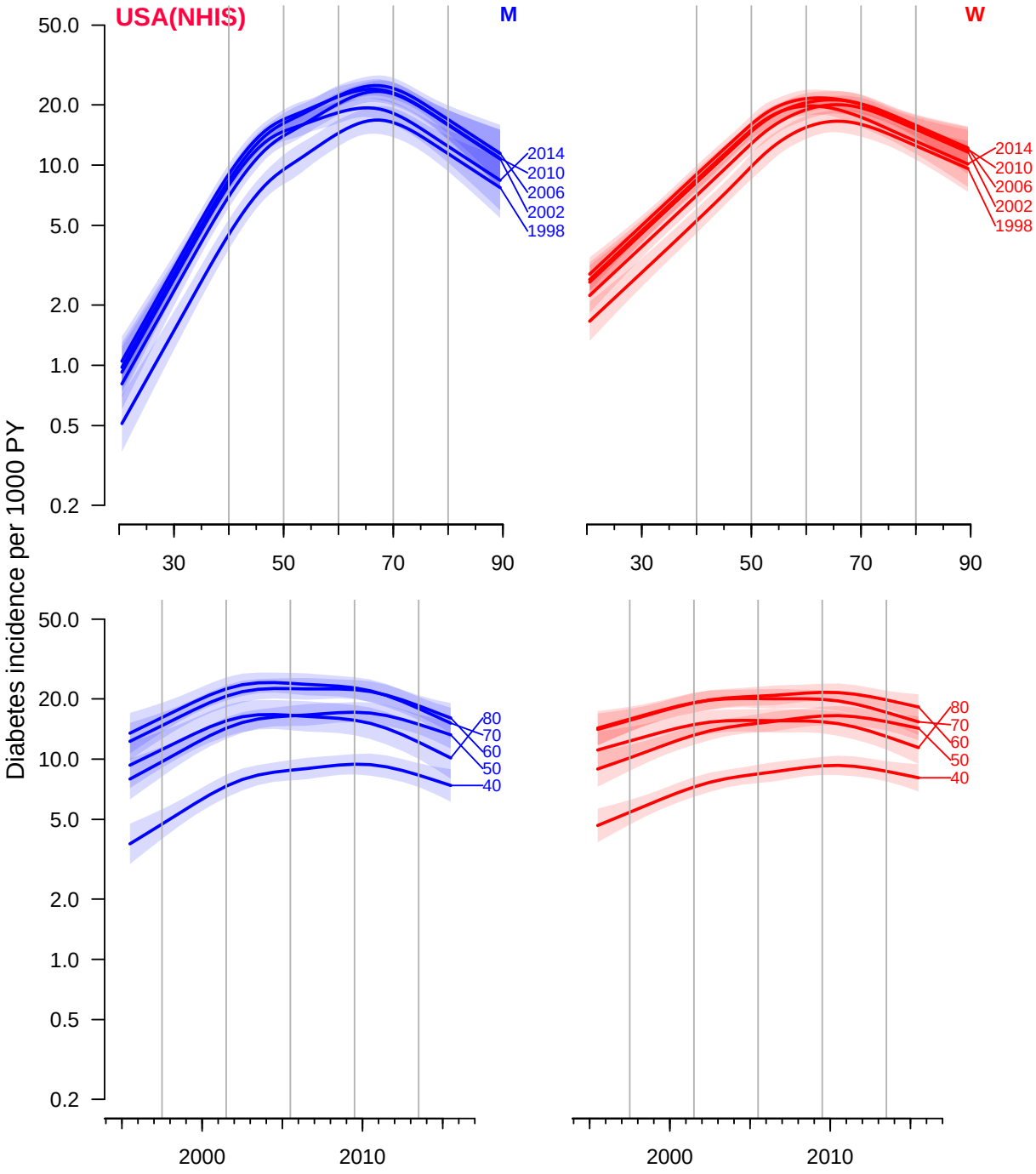

Figure A38: *Estimated incidence rates of diabetes by age and period in USA(NHIS). Estimates are from age-period-cohort models, fitted separately for men and women. Upper panels show age-specific rates at different dates, as indicated by vertical lines in the lower panels. Lower panels show period-specific rates at different ages, as indicated by vertical lines in the upper panels. Left panels (blue curves) are men, right panels (red curves) are women.*

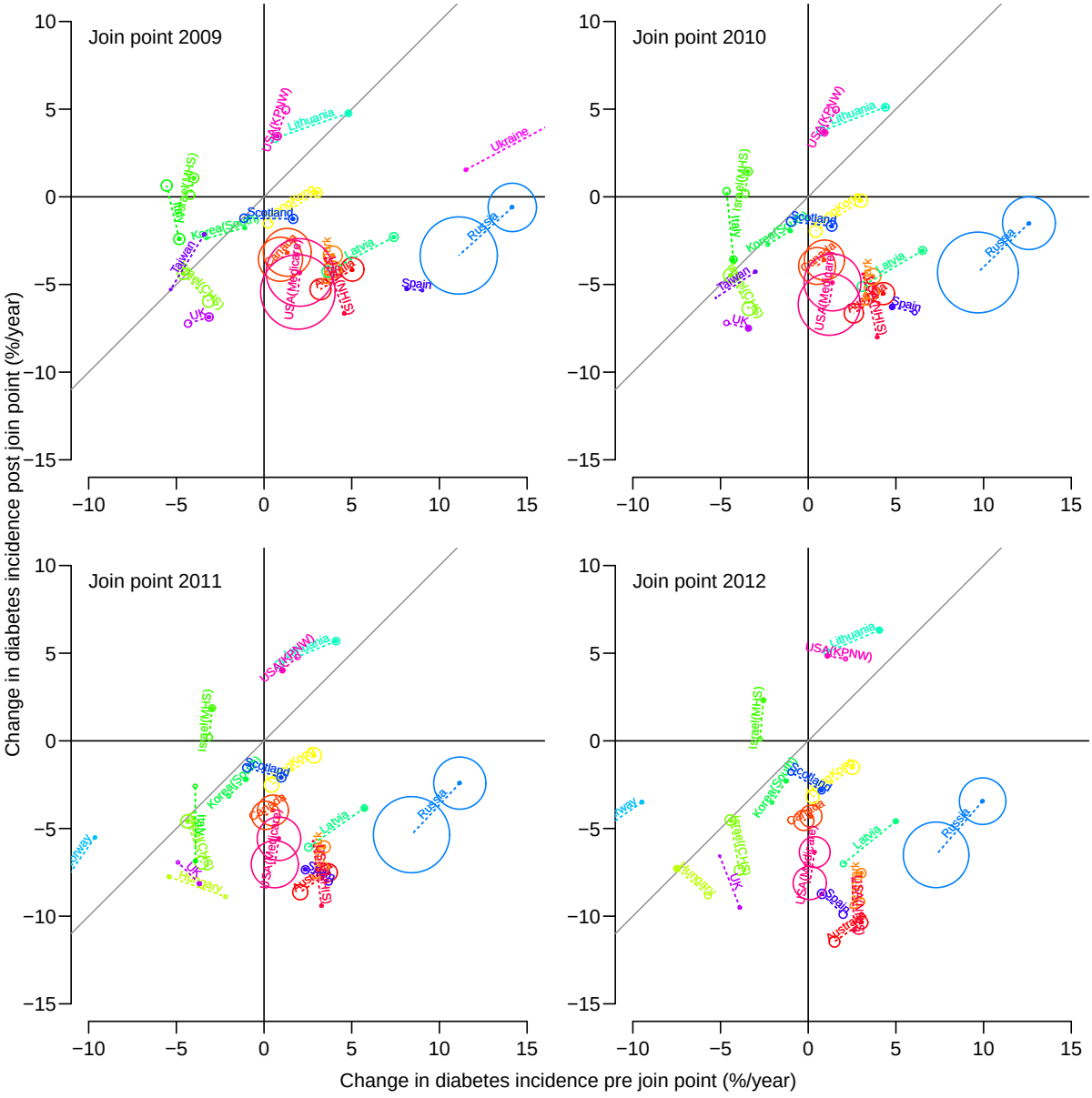

Figure A39: *Estimated changes in incidence of diagnosed total or type 2 diabetes rates pre and post the join points, 2009, 2010, 2011 and 2012. The diagonal lines indicate equality of pre- and post-join point changes in rates, that is no change in trend. Each coloured circle represents a data source and a sex; the area is proportional to the precision (inverse variance) of the sum of the estimated annual changes before and after the join point which is indicated in the corner of each panel. Estimates for men are shown with a dot in the middle of the circle, for women without.*
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

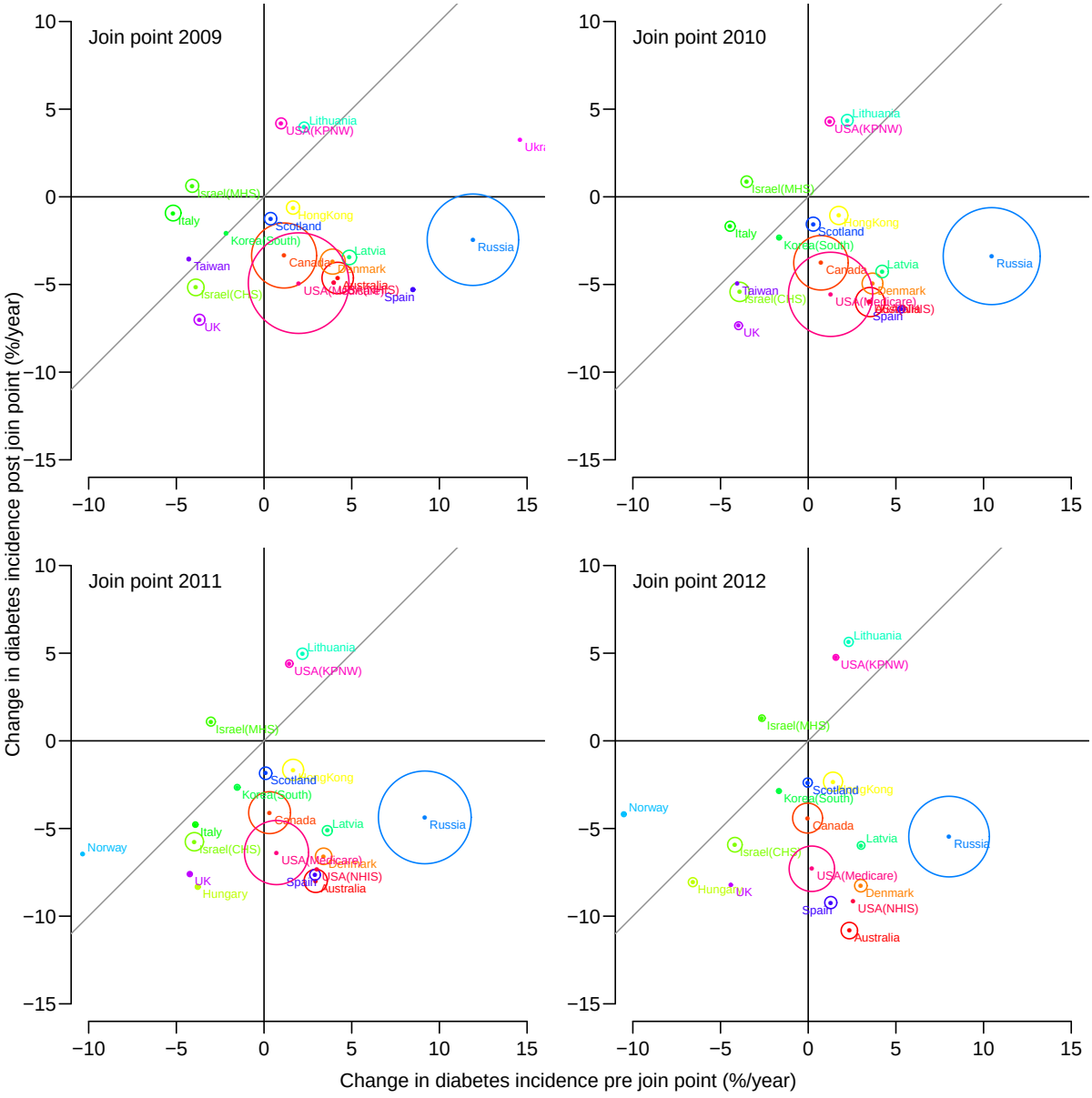

Figure A40: *Estimated changes in incidence of diagnosed total or type 2 diabetes rates pre and post the join points 2009, 2010, 2011 and 2012. The diagonal lines indicate equality of pre- and post-join point changes in rates, that is no change in trend. Each coloured circle represents a data source; the area is proportional to the precision (inverse variance) of the sum of the estimated annual changes before and after the join point which is indicated in the corner of each panel. Estimates are from a model with common slopes for men and women, controlling for sex.*
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

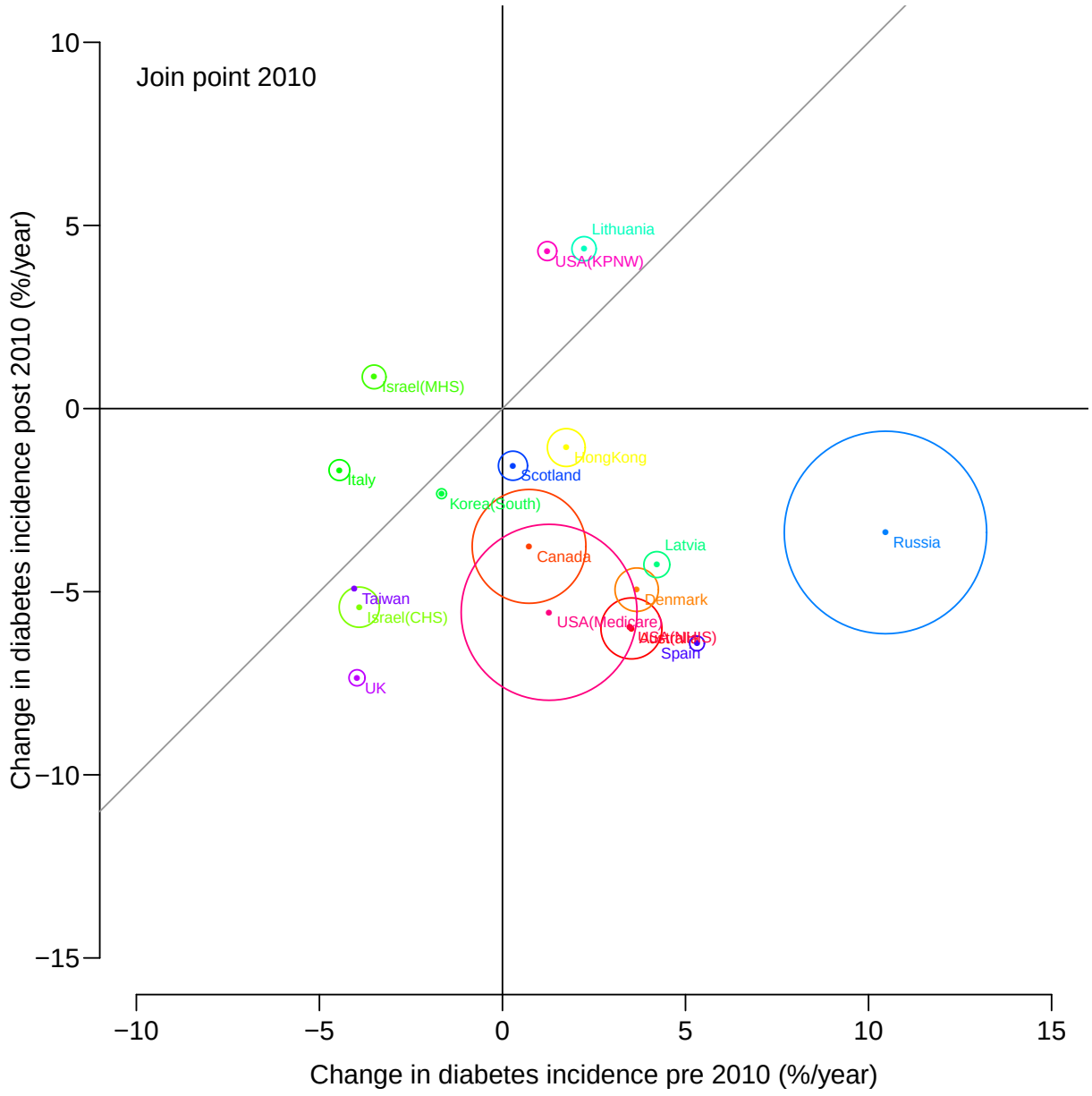

Figure A41: *Estimated annual changes in incidence of diagnosed total or type 2 diabetes rates pre and post the join point 2010. The diagonal line indicates equality of pre- and post-join point changes in rates, that is no change in trend. Each circle represents a data source; the area is proportional to the precision (inverse variance) of the sum of the estimated annual changes before and after the join point. Estimates are from a model with common slopes for men and women, controlling for sex.*
Model fit for the join-point model is poor for Israel(MHS), leading to unreliable estimates of the annual trend in incidence in the later time period.

Trends in the incidence of diagnosed diabetes: a multicountry analysis of aggregate data from 22 million diagnoses in high-income and middle-income settings

Appendix

February 2021
Version 11

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