

Supplementary Information

Supplement to: Paz Lopez-Doriga Ruiz, *et al*: Parental education and occupation in relation to risk of childhood type 1 diabetes: nationwide cohort study

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Supplementary Methods

The Norwegian education and occupation system and data collection

Education is free of charge in Norway, at all levels including PhD. Upper secondary education is compulsory in Norway, and the duration of compulsory education has varied from seven years up to 1969, nine years during 1969-1997, and 10 years after 1997. Number of years of education for a given level may therefore vary by calendar year. The Norwegian standard for educational groups (NUS) started in 1970, with different versions in 1973 and 1989, and data on the population was collected by Statistics Norway in decennial censuses in 1970, 1980, and 1990 (representative subsample in 1990). Parental educational data closest to the birth for the child was used in the analysis for period 1 (1989-2003), while data from 2013 was used for period 2 (2005-2013) as explained the main text methods section and main Figure 1b. The educational codes are explained below:

Original statistics Norway category	Statistics Norway coding	Years of education*	Categories used in the statistical analysis with description
	0	-	1. Lower secondary
Compulsory education	1	1-7 years	
	2	8-10 years	
Middle education	3	Over 8 years	2. Initiated upper secondary (but not completed)
	4	10-13 years	3. Completed upper secondary (high school or vocational education)
	5	13-15 years	4. Post-secondary non-tertiary (started additional education after upper secondary, but not completed any higher degree)
High education	6	15-17 years	5. Bachelor's degree or equivalent
	7	17-19 years	6. Master's degree or equivalent
	8	≥ 20 years	7. PhD level
	9	Not provided / missing	Not included in the analyses

* Number of years has varied over time as explained in the text. In early years those who did not pass and exam after 7 years of compulsory education were coded with zero. For most of the period covered, all residents received level 1 compulsory education (6-7 years) with no requirement to pass a test.

Nordic Classification of Occupations for parents were similarly available for these time points in period 1 (1989-2003) <https://www.nb.no/nbsok/nb/8d2a147fbb144dbb1fa40670315cb966?lang=no#0>

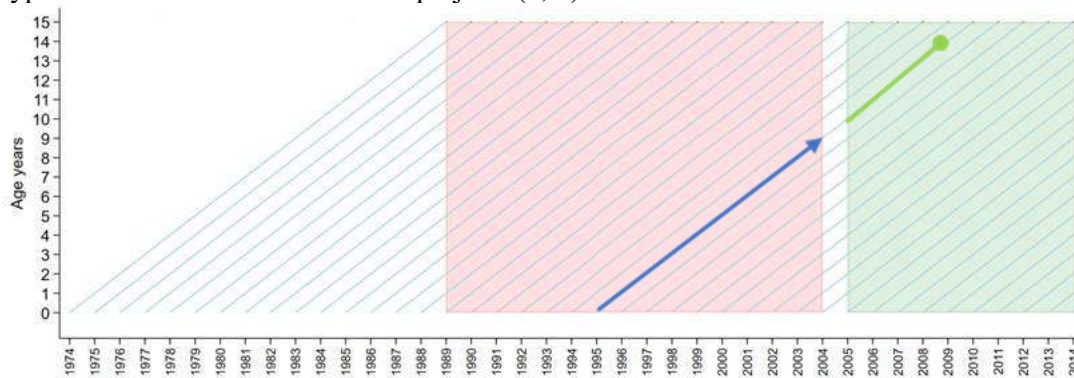
Operational definition of newly diagnosed type 1 diabetes

The study outcome, newly diagnosed clinical type 1 diabetes before age 15 years, was defined using registries, with slightly different operational definitions for the two study periods. For 1989-2003 (the first linked data set), used the Norwegian Childhood Diabetes Registry, a nation-wide medical quality registry with nearly complete coverage which participates in EURODIAB incidence studies (1). This is run by paediatricians specializing in diabetes care throughout Norway. Date of diagnosis defined as the day of the first insulin injection (2). For the period 2005-2013, type 1 diabetes was defined at the first date of dispensing insulin prescriptions according to the Norwegian prescription database (Anatomical Therapeutic Chemical Classification code A10A). We required at least two separate dispensed insulin prescriptions, and no use of sulfonylureas to avoid other types of diabetes. For individuals starting with insulin in 2013, we allowed for the second dose to be dispensed in 2014. To exclude prevalent cases of type 1 diabetes in the second period, we required no use of insulin in 2004, and we were thus not able to include incident type 1 diabetes cases in in 2004 (see also Main Figure 1).

Methods for combining two data sets for maternal and paternal education

We included two datasets, each containing individual linkage of nationwide registries with all individuals who were diagnosed with type 1 diabetes before age 15 years in the Norwegian population during 1989-2003 (pink section in figure), and 2005-2013 (green section in figure) inclusive. These

datasets had previously been used for different purposes, but the study of social inequality in risk of type 1 diabetes was an aim of both projects (3, 4).



The figure (Lexis diagram) shows that children diagnosed in each period could be born before the period of type 1 diabetes ascertainment (a child diagnosed in 1989 could be born 1974-1989, and a child diagnosed in 2005 could be born 1990-2005). In individual-level cohort analysis of each of the two datasets, person-time at follow-up for children born before the periods of ascertainment was not counted before the child was “at risk” of being identified with newly diagnosed type 1 diabetes in the respective pink and green periods (this is often called left truncated survival data, see also additional explanation for the white segment in 2004 below). Children born 1990-2003 appeared in both datasets and contribute person-time at risk of incident type 1 diabetes in different calendar periods at different ages.

How did we ensure that a child was not counted twice? For example, a girl born 1st of January 1995 contributed nine (person-) years of follow-up (1995 – 2004) in the first period (blue thick arrow across the pink area), until her 9th birthday, and she did not develop type 1 diabetes during this first period. From 2005 to 2008, she contributed another four person-years of follow-up, from age 11 until the 14th birthday when she was diagnosed with type 1 diabetes (indicated by the circle at the end of the thick green line). Because both datasets included information about date of birth, date of diagnosis of type 1 diabetes, exposures and covariates, we could cross-classify each individual child’s person-time under follow-up simultaneously by the two time-dependent variables age and calendar period (using the “stsplit” function in Stata we split the person-time for each individual in the two separate datasets in 1-year categories of age and calendar period and category of exposure and covariate). Person-time and number of incident cases were further stratified by exposure and covariates using the “stptime” function in Stata. This allowed us to add the person-time of follow-up (and number of incident cases of type 1 diabetes) for all children in each stratum of age, period, exposure, and covariate from the two datasets, because any child that appeared in both data sets appeared in a different stratum of age- and calendar period in the two data sets. Thus, we could analyse the resulting table of cross-classified person-time and cases of incident type 1 diabetes using Poisson regression just as if we had a single dataset covering the entire period with type 1 diabetes diagnosed from 1989-2013 (5). We modelled these data across the two periods with Poisson regression as described in the main methods section with restricted cubic splines for age and period, which produces results equivalent to that of Cox regression (6). Finally, we could not include follow-up time of incident cases for 2004 (the white vertical segment in the Lexis diagram). This is because newly diagnosed type 1 diabetes in the second period was done using the Norwegian Prescription database and individual using insulin in 2004 contained both incident and prevalent cases of type 1 diabetes. To ensure we had incident (newly diagnosed) cases, we required that individuals had not dispensed insulin prescriptions through 2004.

Formal explanations of the Poisson regression model are given in the cited references (5) and (6), with additional explanations in slides available here: <https://www.bendixcarstensen.com/> (B. Carstensen, who needs the Cox model anyway?).

Briefly, Poisson regression model has a log-link and models the log of the incidence rate as a linear combination of the baseline rate, regression coefficients and covariates including the exposure (example covariates here):

$$\text{Log}[E(IR|x_1, x_2, x_3, \dots, x_n)] = b_0 + b_1 * x_1 + b_2 * x_2 + b_3 * x_3 + \dots b_n * x_n.$$

E refers to the expectation, or mean, and IR is the incidence rate (number of new cases per person-year, and the vertical line indicates that the incidence rate is conditioned on a set of covariates from x_1 up to x_n . b_0 is the baseline rate – the incidence rate among those with coded covariates all equal to zero, and b_1 - b_n are the regression coefficients, or log(IRR) associated with each covariate effect so that the exponentiated regression coefficient is the IRR (incidence rate ratio). Covariates and exposures can be dummy (indicator) variables for categorical variables and splines to model non-linear associations.

Supplementary methods references

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2. Joner G, Stene LC, Søvik O. Nationwide, prospective registration of type 1 diabetes in children aged < 15 years in Norway 1989–1998: no increase but significant regional variation in incidence. *Diabetes Care*. 2004;27(7):1618-22.
3. Ruiz PLD, Tapia G, Bakken IJ, Haberg SE, Hungnes O, Gulseth HL, et al. Pandemic influenza and subsequent risk of type 1 diabetes: a nationwide cohort study. *Diabetologia*. 2018;61(9):1996-2004.
4. Stene LC, Magnus P, Lie RT, Søvik O, Joner G, Norwegian childhood Diabetes Study Group. Birth weight and childhood onset type 1 diabetes: population based cohort study. *BMJ*. 2001;322(7291):889-92.
5. Carstensen B. Age-period-cohort models for the Lexis diagram. *Stat Med*. 2007;26(15):3018-45.
6. Royston P, Lambert PC. Flexible parametric survival analysis using stata: beyond the Cox model. College Station, Texas: Stata Press; 2011.

Supplementary results: Tables

Table S1. Number of incident cases of type 1 diabetes, absolute incidence rates and characteristics for each category of maternal education*

Period 1989-2003

		Lower secondary or less (up to 10 years)	Initiated upper secondary (over 11 years)	Upper secondary completed (13 years)	Post-secondary non-tertiary (14 years)	Bachelor's or equivalent level (17 years education)	Master's or equivalent level (19 years education)	PhD (20 years)
	Total	313, 27.9 (25.0 - 31.2)	707, 25.0 (23.2 - 26.9)	723, 25.9 (24.1 - 27.9)	253, 29.0 (25.6 - 32.8)	272, 21.5 (19.1 - 24.2)	43, 19.5 (14.5 - 26.3)	<5, 17.2 (2.4 - 122.1)
Child's sex	Boys	172, 29.8 (25.7 - 34.6)	374, 25.8 (23.3 - 28.5)	386, 26.9 (24.4 - 29.7)	133, 29.6 (24.9 - 35.0)	145, 22.4 (19.0 - 26.3)	24, 21.0 (14.1 - 31.3)	<5, 34.1 (4.8 - 241.8)
	Girls	141, 25.9 (21.9 - 30.5)	333, 24.1 (21.7 - 26.9)	337, 24.9 (22.4 - 27.7)	120, 28.4 (23.7 - 33.9)	127, 20.6 (17.3 - 24.5)	19, 17.9 (11.4 - 28.1)	-
Maternal age at delivery (years)	<20	25, 25.2 (17.0 - 37.2)	30, 31.9 (22.3 - 45.6)	13, 36.5 (21.2 - 62.8)	-	-	-	-
	20-24	113, 26.3 (21.9 - 31.6)	166, 19.4 (16.7 - 22.6)	221, 27.1 (23.8 - 31.0)	29, 38.6 (26.8 - 55.5)	13, 18.7 (10.8 - 32.1)	12, 18.4 (10.5 - 32.4)	-
	25-29	100, 29.1 (23.9 - 35.4)	270, 25.5 (22.6 - 28.7)	324, 25.8 (23.1 - 28.7)	94, 24.6 (20.1 - 30.1)	115, 21.3 (17.7 - 25.6)	25, 22.8 (15.4 - 33.7)	<5, 34.9 (4.9 - 247.6)
	30-34	58, 32.0 (24.7 - 41.4)	187, 30.4 (26.3 - 35.1)	132, 23.7 (20.0 - 28.1)	85, 27.3 (22.1 - 33.7)	101, 20.9 (17.2 - 25.3)	6, 14.0 (6.3 - 31.1)	-
	≥ 35	17, 25.2 (15.7 - 40.5)	54, 25.8 (19.7 - 33.6)	33, 26.3 (18.7 - 37.0)	45, 43.7 (32.7 - 58.6)	43, 25.1 (18.6 - 33.8)	19, 19.4 (12.4 - 30.5)	-
Parity	1st	126, 29.9 (25.1 - 35.6)	254, 24.5 (21.7 - 27.7)	355, 26.1 (23.5 - 28.9)	114, 30.5 (25.4 - 36.6)	109, 20.0 (16.6 - 24.1)	17, 20.4 (12.7 - 32.9)	<5, 44.3 (6.2 - 314.6)
	2nd	111, 27.8 (23.0 - 33.4)	267, 24.3 (21.5 - 27.4)	282, 27.8 (24.8 - 31.3)	83, 25.2 (20.3 - 31.3)	109, 23.0 (19.1 - 27.8)	6, 18.6 (8.4 - 41.4)	-
	3rd	54, 25.6 (19.6 - 33.4)	135, 25.6 (21.6 - 30.3)	67, 19.7 (15.5 - 25.0)	43, 31.7 (23.5 - 42.7)	43, 21.5 (16.0 - 29.0)	-	-
	4th	16, 25.0 (15.3 - 40.8)	44, 34.5 (25.6 - 46.3)	18, 29.4 (18.5 - 46.7)	7, 25.1 (12.0 - 52.7)	8, 20.4 (10.2 - 40.8)	<5, 85.8 (12.1 - 609.1)	-
	≥5th	6, 23.3 (10.5 - 51.8)	7, 17.3 (8.3 - 36.4)	<5, 7.0 (1.0 - 49.8)	6, 91.2 (41.0 - 202.9)	<5, 35.7 (11.5 - 110.7)	38, 19.8 (14.4 - 27.2)	<5, 20.0 (2.8 - 141.8)
Caesarean section	No	263, 26.3 (23.3 - 29.7)	624, 24.9 (23.0 - 26.9)	645, 26.0 (24.1 - 28.1)	216, 27.9 (24.4 - 31.8)	243, 21.8 (19.2 - 24.7)	5, 17.4 (7.2 - 41.8)	-
	Yes	50, 40.8 (30.9 - 53.8)	83, 25.7 (20.8 - 31.9)	78, 25.0 (20.0 - 31.2)	37, 37.8 (27.4 - 52.2)	29, 19.2 (13.3 - 27.6)	-	-
Paternal age at delivery (years)	<25	72, 26.2 (20.8 - 33.0)	104, 23.2 (19.1 - 28.1)	112, 30.9 (25.7 - 37.2)	12, 35.9 (20.4 - 63.2)	7, 20.4 (9.7 - 42.7)	7, 16.9 (8.0 - 35.4)	-
	25-29	110, 26.8 (22.2 - 32.3)	240, 22.8 (20.1 - 25.9)	291, 25.8 (23.0 - 28.9)	82, 29.6 (23.8 - 36.7)	77, 21.7 (17.4 - 27.1)	25, 24.8 (16.8 - 36.7)	<5, 47.1 (6.6 - 334.0)
	30-34	88, 30.9 (25.1 - 38.1)	246, 28.4 (25.1 - 32.2)	217, 24.3 (21.3 - 27.7)	96, 26.5 (21.7 - 32.4)	105, 20.1 (16.6 - 24.3)	10, 17.1 (9.2 - 31.8)	-
	35-39	33, 27.6 (19.6 - 38.8)	97, 26.5 (21.8 - 32.4)	91, 27.8 (22.7 - 34.2)	50, 30.1 (22.8 - 39.7)	67, 25.0 (19.7 - 31.8)	<5, 5.5 (0.8 - 39.1)	-
	≥40	10, 31.0 (16.7 - 57.6)	20, 20.3 (13.1 - 31.5)	12, 15.4 (8.7 - 27.1)	13, 37.9 (22.0 - 65.4)	16, 18.3 (11.2 - 29.9)	43, 19.5 (14.5 - 26.3)	<5, 17.2 (2.4 - 122.1)

Table S1, continued. Period 2005-2013

		Started lower secondary (10 years education)	Upper secondary (over 11 years)	Upper secondary completed (13 years)	Post-secondary non- tertiary (14 years)	Bachelor's or equivalent level (17 years education)	Master's or equivalent level (19 years education)	PhD (20 years)
	Total	369, 38.9 (35.1 - 43.1)	150, 41.4 (35.3 - 48.6)	741, 40.6 (37.8 - 43.6)	65, 40.0 (31.4 - 51.0)	847, 34.9 (32.6 - 37.3)	152, 29.5 (25.2 - 34.6)	11, 27.5 (15.2 - 49.6)
Child's sex	Boys	213, 43.6 (38.1 - 49.9)	80, 42.9 (34.5 - 53.5)	412, 44.0 (39.9 - 48.4)	41, 49.2 (36.2 - 66.8)	433, 34.8 (31.7 - 38.2)	871, 26.9 (21.3 - 34.0)	8, 38.5 (19.3 - 77.1)
	Girls	156, 33.9 (29.0 - 39.6)	70, 39.8 (31.5 - 50.3)	329, 37.0 (33.2 - 41.2)	24, 30.3 (20.3 - 45.2)	414, 35.0 (31.7 - 38.5)	81, 32.3 (25.9 - 40.1)	<5, 15.6 (5.0 - 48.2)
Maternal age at delivery (years)	<20	27, 33.3 (22.9 - 48.6)	<5, 95.3 (30.7 - 295.4)	21, 40.6 (26.5 - 62.2)	-	10, 43.1 (23.2 - 80.1)	-	-
	20-24	90, 35.2 (28.6 - 43.2)	21, 43.3 (28.2 - 66.4)	161, 39.6 (34.0 - 46.3)	13, 66.3 (38.5 - 114.2)	97, 37.2 (30.5 - 45.4)	5, 25.4 (10.6 - 61.1)	-
	25-29	114, 41.3 (34.3 - 49.6)	51, 43.3 (32.9 - 57.0)	297, 43.8 (39.1 - 49.1)	20, 36.4 (23.5 - 56.4)	302, 33.5 (29.9 - 37.5)	47, 32.0 (24.0 - 42.6)	<5, 41.7 (15.6 - 111)
	30-34	93, 43.3 (35.3 - 53.0)	42, 36.6 (27.0 - 49.5)	179, 36.3 (31.4 - 42.0)	22, 39.1 (25.7 - 59.4)	316, 36.5 (32.7 - 40.8)	64, 27.4 (21.4 - 35.0)	5, 27.7 (11.5 - 66.5)
	≥ 35	45, 37.2 (27.8 - 49.9)	33, 42.2 (30.0 - 59.4)	83, 42.0 (33.9 - 52.1)	10, 34.1 (18.4 - 63.4)	122, 32.2 (27.0 - 38.5)	36, 31.9 (23.0 - 44.3)	<5, 17.3 (4.3 - 69.2)
Parity	1st	122, 34.8 (29.2 - 41.6)	42, 39.9 (29.5 - 54.0)	291, 38.4 (34.3 - 43.1)	29, 46.3 (32.2 - 66.6)	345, 33.3 (29.9 - 37.0)	77, 32.5 (26.0 - 40.7)	<5, 17.3 (5.6 - 53.7)
	2nd	126, 40.0 (33.6 - 47.6)	59, 43.2 (33.5 - 55.8)	292, 43.1 (38.5 - 48.4)	26, 41.6 (28.4 - 61.2)	306, 34.4 (30.8 - 38.5)	46, 24.8 (18.6 - 33.2)	5, 32.8 (13.6 - 78.8)
	3rd	81, 44.6 (35.9 - 55.5)	34, 41.2 (29.4 - 57.6)	122, 41.3 (34.6 - 49.3)	7, 24.5 (11.7 - 51.5)	155, 39.5 (33.8 - 46.3)	19, 25.4 (16.2 - 39.9)	<5, 32.5 (8.1 - 130.0)
	4th	28, 41.5 (28.6 - 60.1)	11, 41.8 (23.1 - 75.4)	28, 38.8 (26.8 - 56.2)	<5, 29.1 (7.3 - 116.4)	38, 43.9 (32.0 - 60.4)	7, 47.4 (22.6 - 99.4)	<5, 92.2 (13.0 - 655)
	≥5th	12, 34.7 (19.7 - 61.1)	<5, 34.5 (13.0 - 92.0)	8, 32.6 (16.3 - 65.2)	<5, 49.7 (7.0 - 352.6)	<5, 12.3 (4.0 - 38.2)	<5, 87.9 (28.3 - 272.4)	-
Caesarean section	No	310, 38.6 (34.5 - 43.1)	123, 40.2 (33.7 - 48.0)	631, 40.4 (37.4 - 43.7)	57, 41.5 (32.0 - 53.8)	710, 34.0 (31.6 - 36.6)	132, 29.8 (25.1 - 35.3)	9, 26.3 (13.7 - 50.6)
	Yes	59, 40.7 (31.5 - 52.5)	27, 47.8 (32.8 - 69.7)	110, 41.4 (34.3 - 49.9)	8, 31.9 (16.0 - 63.8)	137, 40.1 (33.9 - 47.4)	20, 28.1 (18.1 - 43.6)	<5, 34.3 (8.6 - 137.1)
Paternal age at delivery (years)	<25	64, 36.2 (28.4 - 46.3)	9, 36.6 (19.0 - 70.3)	89, 41.9 (34.1 - 51.6)	<5, 9.4 (1.3 - 66.9)	49, 37.1 (28.0 - 49.1)	<5, 18.7 (4.7 - 74.9)	-
	25-29	116, 43.6 (36.4 - 52.3)	45, 50.1 (37.4 - 67.1)	232, 41.7 (36.7 - 47.5)	20, 49.9 (32.2 - 77.4)	214, 33.7 (29.5 - 38.5)	33, 34.7 (24.6 - 48.8)	<5, 15.5 (2.2 - 109.7)
	30-34	91, 35.8 (29.1 - 43.9)	46, 38.5 (28.8 - 51.4)	234, 39.3 (34.5 - 44.6)	20, 34.3 (22.1 - 53.2)	318, 34.9 (31.2 - 38.9)	64, 30.2 (23.6 - 38.5)	5, 32.8 (13.7 - 78.9)
	35-39	65, 42.2 (33.1 - 53.8)	35, 43.0 (30.9 - 59.9)	138, 43.4 (36.8 - 51.3)	19, 53.1 (33.9 - 83.3)	182, 35.2 (30.4 - 40.7)	38, 28.4 (20.7 - 39.1)	<5, 34.1 (12.8 - 90.9)
	≥40	26, 30.5 (20.8 - 44.8)	15, 32.9 (19.8 - 54.6)	48, 35.5 (26.8 - 47.2)	5, 29.4 (12.3 - 70.7)	82, 36.8 (29.7 - 45.7)	15, 24.7 (14.9 - 41.0)	<5, 16.3 (2.3 - 115.6)

* Data in each column: the first number is the number of incident type 1 diabetes cases, and after comma the incidence rate per 100,000 person-years followed by (95% confidence interval). Number of individuals <5 could not be specified because of data protection rules.

Table S2. Maternal and paternal education and incidence of type 1 diabetes separately in period 1 (1989-2003) and period 2 (2005-2013)

Maternal education			
	Period 1 (1989-2003)	Period 2 (2005-2013)	Periods combined
	aIRR (95% CI)*	aIRR (95% CI)*	aIRR (95% CI)*
Lower secondary	1.04 (0.91 - 1.20)	0.94 (0.83 - 1.06)	0.98 (0.89 - 1.08)
Initiated upper secondary	0.93 (0.83 - 1.03)	0.89 (0.74 - 1.06)	0.91 (0.83 - 0.99)
Completed upper secondary (high school or vocational education)	1 (Reference)	1 (Reference)	1 (Reference)
Post-secondary non-tertiary (started but not completed any higher degree)	1.03 (0.89 - 1.19)	0.95 (0.73 - 1.22)	1.01 (0.90 - 1.15)
Bachelor's degree or equivalent	0.86 (0.75 - 1.00)	0.90 (0.81 - 0.99)	0.89 (0.82 - 0.97)
Master's degree or equivalent level	0.79 (0.57 - 1.07)	0.83 (0.70 - 0.99)	0.82 (0.70 - 0.95)
PhD level	0.74 (0.10 - 5.27)	0.74 (0.41 - 1.34)	0.73 (0.41 - 1.29)
Paternal education			
	Period 1 (1989-2003)	Period 2 (2005-2013)	Periods combined
	aIRR (95% CI)*	aIRR (95% CI)*	aIRR (95% CI)*
Lower secondary	0.86 (0.75 - 0.98)	1.06 (0.95 - 1.20)	0.96 (0.88 - 1.05)
Initiated upper secondary	0.97 (0.87 - 1.08)	0.93 (0.78 - 1.11)	0.97 (0.89 - 1.06)
Completed upper secondary (high school or vocational education)	1 (Reference)	1 (Reference)	1 (Reference)
Post-secondary non-tertiary (started but not completed any higher degree)	0.88 (0.76 - 1.03)	0.91 (0.76 - 1.10)	0.90 (0.80 - 1.01)
Bachelor's degree or equivalent	0.85 (0.72 - 1.00)	1.04 (0.93 - 1.16)	0.97 (0.89 - 1.06)
Master's degree or equivalent level	0.96 (0.80 - 1.15)	0.93 (0.79 - 1.08)	0.93 (0.83 - 1.05)
PhD level	1.11 (0.53 - 2.34)	1.09 (0.74 - 1.62)	1.08 (0.76 - 1.52)

* Incidence rate ratios (aIRR) for type 1 diabetes, adjusted for maternal age, parity, caesarean section, county of residence, and child's sex. CI: Confidence interval.

Table S3. Characteristics of all subjects born 1999-2013 and the subgroup with information on maternal smoking

		All births from 1999-2013			Births 1999-2013 with information on maternal smoking*		
		Person-years	T1D cases	Incidence Rate (per 100 000 PYR)	Person-years	T1D cases	Incidence Rate (per 100 000 PYR)
	Total	4263652	1347	31.6 (29.9 - 33.3)	3468807	1108	31.9 (30.1 - 33.9)
Sex	Boys	2186566	715	32.7 (30.4 - 35.2)	1778712	593	33.3 (30.8 - 36.1)
	Girls	2077086	632	30.4 (28.1 - 32.9)	1690095	515	30.5 (28.0 - 33.2)
Mother age	<20 years	100210	31	30.9 (21.8 - 44.0)	85070	26	30.6 (20.8 - 44.9)
	20-24 years	613210	206	33.6 (29.3 - 38.5)	513674	170	33.1 (28.5 - 38.5)
	25-29 years	1419568	454	32.0 (29.2 - 35.1)	1161363	374	32.2 (29.1 - 35.6)
	30-34 years	1437848	451	31.4 (28.6 - 34.4)	1153007	366	31.7 (28.7 - 35.2)
	≥ 35 years	692805	205	29.6 (25.8 - 33.9)	555688	172	31.0 (26.7 - 35.9)
Parity	1st	1744831	539	30.9 (28.4 - 33.6)	1413085	449	31.8 (29.0 - 34.9)
	2nd	1550257	473	30.5 (27.9 - 33.4)	1259698	380	30.2 (27.3 - 33.4)
	3rd	711277	242	34.0 (30.0 - 38.6)	583463	201	34.4 (30.0 - 39.6)
	4th	186938	71	38.0 (30.1 - 47.9)	154877	61	39.4 (30.6 - 50.6)
	≥5th	70350	22	31.3 (20.6 - 47.5)	57684	17	29.5 (18.3 - 47.4)
Caesarean section	No	3605606	1122	31.1 (29.3 - 33.0)	2945515	927	31.5 (29.5 - 33.6)
	Yes	658046	225	34.2 (30.0 - 39.0)	523292	181	34.6 (29.9 - 40.0)
Paternal age	<25 years	339151	120	35.4 (29.6 - 42.3)	284949	100	35.1 (28.8 - 42.7)
	25-29 years	1063260	331	31.1 (28.0 - 34.7)	872111	287	32.9 (29.3 - 36.9)
	30-34 years	1516576	476	31.4 (28.7 - 34.3)	1224784	378	30.9 (27.9 - 34.1)
	35-39 years	906455	288	31.8 (28.3 - 35.7)	732697	237	32.3 (28.5 - 36.7)
	≥40 years	411728	126	30.6 (25.7 - 36.4)	332815	100	30.0 (24.7 - 36.6)
Maternal education							
	Lower secondary	582338	174	29.9 (25.8 - 34.7)	489260	146	29.8 (25.4 - 35.1)
	Started upper secondary	167607	54	32.2 (24.7 - 42.1)	136935	43	31.4 (23.3 - 42.3)
	Completed upper secondary (high school or vocational education)	1226071	433	35.3 (32.1 - 38.8)	1016683	364	35.8 (32.3 - 39.7)
	Post-secondary non-tertiary (started but not completed any higher degree)	98838	35	35.4 (25.4 - 49.3)	80765	27	33.4 (22.9 - 48.7)
	Bachelor's degree or equivalent	1756924	547	31.1 (28.6 - 33.9)	1415143	451	31.9 (29.1 - 35.0)
	Master's degree or equivalent	398829	96	24.1 (19.7 - 29.4)	304720	71	23.3 (18.5 - 29.4)
	PhD level	28737	8	27.8 (13.9 - 55.7)	21813	6	27.5 (12.4 - 61.2)

*Information on maternal smoking was available for births from 1999. Providing information is optional and was provided by 81.4% of the person-years under observation. T1D: Type 1 diabetes. PYR: Person-years of observation.

Table S4. Robustness analysis: Associations of maternal education with incidence of type 1 diabetes after further adjustment for maternal type 1 diabetes*

Maternal education				
	Period 1 (1989-2003)	Period 1 with additional adjustment for maternal T1D*	Period 2 (2005-2013)	Period 2 with additional adjustment for maternal T1D*
	aIRR (95% CI)†	aIRR (95% CI)†	aIRR (95% CI)†	aIRR (95% CI)†
Lower secondary	1.04 (0.91 - 1.20)	1.04 (0.91 - 1.20)	0.94 (0.83 - 1.06)	0.84 (0.70 - 1.00)
Started upper secondary	0.93 (0.83 - 1.03)	0.93 (0.83 - 1.03)	0.89 (0.74 - 1.06)	0.81 (0.61 - 1.07)
Completed upper secondary (high school or vocational education)	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Post-secondary non-tertiary (started but not completed any higher degree)	1.03 (0.89 - 1.19)	1.03 (0.89 - 1.19)	0.95 (0.73 - 1.22)	0.98 (0.69 - 1.38)
Bachelor's degree or equivalent	0.86 (0.75 - 1.00)	0.86 (0.75 - 0.99)	0.90 (0.81 - 0.99)	0.92 (0.81 - 1.05)
Master's degree or equivalent level	0.79 (0.57 - 1.07)	0.79 (0.58 - 1.08)	0.83 (0.70 - 0.99)	0.77 (0.61 - 0.97)
PhD level	0.74 (0.10 - 5.27)	0.73 (0.10 - 5.22)	0.74 (0.41 - 1.34)	0.87 (0.43 - 1.77)

* Maternal type 1 diabetes was available with less than complete coverage for mothers in period 1 and from the Medical Birth Registry for births from 1999 onwards (Period 2).

† Incidence rate ratios (aIRR) for type 1 diabetes, adjusted for maternal age, parity, caesarean section, county of residence, and child's sex. CI: Confidence interval.

Table S5. Robustness analysis: Associations of maternal and paternal education with childhood-onset type 1 diabetes if using parental education ascertained at different time-points*

Maternal education			
	Period 1 (1989-2003): main analysis (education near birth of child)	Period 1: used subsequent available information on education if missing)*	Period 1: used education in the year 2001 for all subjects
	aIRR (95% CI)†	aIRR (95% CI)†	aIRR (95% CI)†
Lower secondary	1.04 (0.91 - 1.20)	1.04 (0.91 - 1.20)	1.12 (0.96 - 1.30)
Started upper secondary	0.93 (0.83 - 1.03)	0.93 (0.84 - 1.04)	0.96 (0.86 - 1.07)
Completed upper secondary (high school or vocational education)	Ref.	Ref.	Ref.
Post-secondary non-tertiary (started but not completed any higher degree)	1.03 (0.89 - 1.19)	1.03 (0.89 - 1.20)	1.28 (1.02 - 1.61)
Bachelor's degree or equivalent	0.86 (0.75 - 1.00)	0.86 (0.75 - 0.99)	0.90 (0.79 - 1.01)
Master's degree or equivalent level	0.79 (0.57 - 1.07)	0.79 (0.58 - 1.07)	0.87 (0.67 - 1.14)
PhD level	0.74 (0.10 - 5.27)	0.74 (0.10 - 5.25)	0.43 (0.11 - 1.71)
Paternal education			
	Period 1 (1989-2003): main analysis (education near birth of child)	Period 1: used subsequent available information on education)*	Period 1: used education in the year 2001 for all subjects
	aIRR (95% CI)†	aIRR (95% CI)†	aIRR (95% CI)†
Lower secondary	0.86 (0.75 - 0.98)	0.86 (0.75 - 0.98)	0.85 (0.73 - 0.99)
Started upper secondary	0.97 (0.87 - 1.08)	0.97 (0.87 - 1.08)	1.05 (0.94 - 1.16)
Completed upper secondary (high school or vocational education)	Ref.	Ref.	Ref.
Post-secondary non-tertiary (started but not completed any higher degree)	0.88 (0.76 - 1.03)	0.88 (0.76 - 1.03)	0.86 (0.69 - 1.07)
Bachelor's degree or equivalent	0.85 (0.72 - 1.00)	0.86 (0.73 - 1.01)	0.93 (0.82 - 1.05)
Master's degree or equivalent level	0.96 (0.80 - 1.15)	0.97 (0.81 - 1.16)	0.95 (0.80 - 1.13)
PhD level	1.11 (0.53 - 2.34)	1.11 (0.52 - 2.33)	0.86 (0.51 - 1.47)

* If education was missing in the survey closest to the birth of the child, we used the next available information, typically 10 years later.

† Incidence rate ratios (aIRR) for type 1 diabetes, adjusted for maternal age, parity, caesarean section, county of residence, and child's sex. CI: Confidence interval.

Table S6. Characteristics of all subjects in the first period (1989-2003) and the subgroup with information on parental occupations

Covariate		All subjects in period 1989-2003			Subjects in period 1989-2003 with information on parental occupation		
		T1D cases	Person-years	Incidence rate per 100 000 PYR (95% CI)	T1D cases	Person-years	Incidence rate per 100 000 PYR (95% CI)
	Total	2325	9192165	25.3 (24.3 - 26.3)	1497	5558402	26.9 (25.6 - 28.3)
Sex	Boys	1242	4723688	26.3 (24.9 - 27.8)	802	2853749	28.1 (26.2 - 30.1)
	Girls	1083	4468300	24.2 (22.8 - 25.7)	695	2704521	25.7 (23.9 - 27.7)
Maternal age at delivery	<20 y	79	269577	29.3 (23.5 - 36.5)	32	103119	31.0 (21.9 - 43.9)
	20-24 y	544	2261783	24.1 (22.1 - 26.2)	325	1333472	24.4 (21.9 - 27.2)
	25-29 y	915	3661699	25.0 (23.4 - 26.7)	647	2412386	26.8 (24.8 - 29.0)
	30-34 y	589	2272315	25.9 (23.9 - 28.1)	383	1350477	28.4 (25.7 - 31.3)
	≥ 35 y	198	726791	27.2 (23.7 - 31.3)	110	358948	30.6 (25.4 - 36.9)
Parity	1st	990	3889582	25.5 (23.9 - 27.1)	605	2224674	27.2 (25.1 - 29.5)
	2nd	870	3419412	25.4 (23.8 - 27.2)	579	2158833	26.8 (24.7 - 29.1)
	3rd	348	1456259	23.9 (21.5 - 26.5)	238	916999	26.0 (22.9 - 29.5)
	4th	93	329224	28.2 (23.1 - 34.6)	58	202547	28.6 (22.1 - 37.0)
	≥5th	24	97688	24.6 (16.5 - 36.7)	17	55349	30.7 (19.1 - 49.4)
Caesarean section	No	2041	8146319	25.1 (24.0 - 26.2)	1323	4948219	26.7 (25.3 - 28.2)
	yes	284	1045846	27.2 (24.2 - 30.5)	174	610183	28.5 (24.6 - 33.1)
Paternal age	<25 y	315	1192733	26.4 (23.6 - 29.5)	148	526070	28.1 (23.9 - 33.1)
	25-29 y	810	3288251	24.6 (23.0 - 26.4)	562	2194065	25.6 (23.6 - 27.8)
	30-34 y	780	3046489	25.6 (23.9 - 27.5)	546	1957218	27.9 (25.7 - 30.3)
	35-39 y	348	1313297	26.5 (23.9 - 29.4)	212	736591	28.8 (25.2 - 32.9)
	≥40 y	72	351394	20.5 (16.3 - 25.8)	29	144459	20.1 (14.0 - 28.9)

PYR: Person-years of follow-up. T1D: Type 1 diabetes. CI: Confidence interval.

Table S7. Explorative analyses: Subcategories of parental occupation and incidence of childhood-onset type 1 diabetes*

Maternal occupation	T1D cases	Incidence rate per 100 000 person-years (95% CI)	Incidence rate ratio (95% CI)
04: Nurse and assistant nurse	186	30.2 (26.12 - 34.82)	1 (Reference)
06: Teaching professionals	74	31.2 (24.83 - 39.17)	1.03 (0.79 - 1.35)
20: Office workers	23	22.8 (15.14 - 34.28)	0.76 (0.49 - 1.16)
21: Office workers / stenographers	23	27.4 (18.19 - 41.20)	0.91 (0.59 - 1.40)
29: Other clerical workers	148	28.6 (24.38 - 33.64)	0.95 (0.77 - 1.18)
33: Trade work	145	31.8 (27.01 - 37.41)	1.05 (0.85 - 1.31)
41: Farmers	28	32.6 (22.53 - 47.26)	1.08 (0.73 - 1.61)
67: Postal workers	33	31.8 (22.64 - 44.79)	1.06 (0.73 - 1.53)
71: Tailors, sewers and related trades workers	20	36.5 (23.56 - 56.60)	1.21 (0.76 - 1.92)
91: Hotel, restaurant and household workers	60	18.3 (14.23 - 23.60)	0.61 (0.45 - 0.81)
92: Serving work	21	21.0 (13.67 - 32.16)	0.70 (0.44 - 1.09)
93: Cleaners	43	23.5 (17.41 - 31.66)	0.78 (0.56 - 1.08)
0X: Miscellaneous other professionals	25	34.6 (23.38 - 51.20)	1.15 (0.76 - 1.74)
Paternal occupation	T1D Cases	Incidence rate per 100 000 person-years (95% CI)	Incidence rate ratio (95% CI)
00: Technical, scientific, humanistic, and artistic work	52	20.7 (15.81 - 27.22)	0.76 (0.56 - 1.05)
06: Teaching professionals	49	29.6 (22.34 - 39.11)	1.09 (0.79 - 1.50)
11: Corporate and organizational management	26	29.2 (19.88 - 42.89)	1.08 (0.71 - 1.63)
29: Other clerical workers	44	33.2 (24.68 - 44.56)	1.22 (0.87 - 1.71)
33: Trade workers	78	32.1 (25.73 - 40.11)	1.18 (0.90 - 1.56)
40: Farmers	39	26.1 (19.06 - 35.70)	0.96 (0.68 - 1.37)
41: Farmer workers	42	28.0 (20.69 - 37.88)	1.03 (0.73 - 1.45)
64: Drivers	83	27.8 (22.38 - 34.41)	1.02 (0.78 - 1.34)
75: Metal, machinery, and related trade workers	153	27.1 (23.15 - 31.78)	1 (Reference)
76: Electrical and electronic trades workers	79	28.9 (23.16 - 35.99)	1.06 (0.81 - 1.40)
77: Woodworkers (e.g. carpenters and sawmill workers)	94	28.2 (23.03 - 34.50)	1.04 (0.80 - 1.34)
79: Other building and construction work	28	20.7 (14.30 - 29.99)	0.76 (0.51 - 1.14)
82: Food processing and related trades workers	28	26.5 (18.31 - 38.41)	0.98 (0.65 - 1.46)
85: Other manufacturing worker	20	44.3 (28.55 - 68.58)	1.63 (1.02 - 2.60)
87: Construction machine drivers	42	28.1 (20.74 - 37.97)	1.03 (0.74 - 1.46)
88: Storing and goods handling labourers	32	24.9 (17.59 - 35.17)	0.92 (0.63 - 1.34)
91: Hotel, restaurant, and household worker	25	42.8 (28.94 - 63.37)	1.58 (1.03 - 2.41)
0X: Miscellaneous other professionals	31	33.4 (23.47 - 47.46)	1.23 (0.84 - 1.81)
A1: Armed forces	63	25.5 (19.89 - 32.59)	0.94 (0.70 - 1.26)

* The next highest level of detail in the Nordic occupational category coding (2 digits) included 82 categories. The table shows results for the 13 maternal occupation categories (representing a total of 829 T1D cases) and 19 paternal occupation categories (representing a total of 1008 T1D cases) which satisfied the predefined inclusion criterion of having at least 20 observed cases of incident type 1 diabetes. The category with the highest number of T1D cases were chosen as the reference category separately for maternal and paternal occupations. Codes according to the Nordic Classification of Occupations. T1D: Type 1 diabetes. CI: Confidence Interval.

<https://www.nb.no/nbsok/nb/8d2a147fbb144dbb1fa40670315cb966?lang=no#0>

Supplementary results: Figures

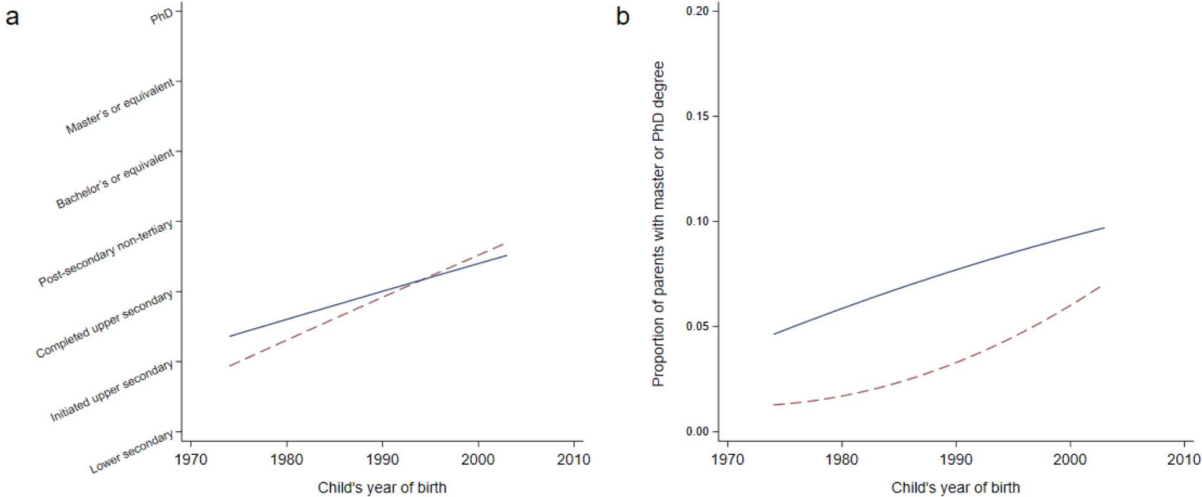


Figure S1. Time trends in parental education in Norway
a) Mean parental education at child's birth in the period 1989-2003. b) Proportion of parents with master or PhD degree at the time of child's birth. Maternal education red dash line and paternal education in solid blue. Correlation between maternal and paternal education: Spearman coefficient=0.43.

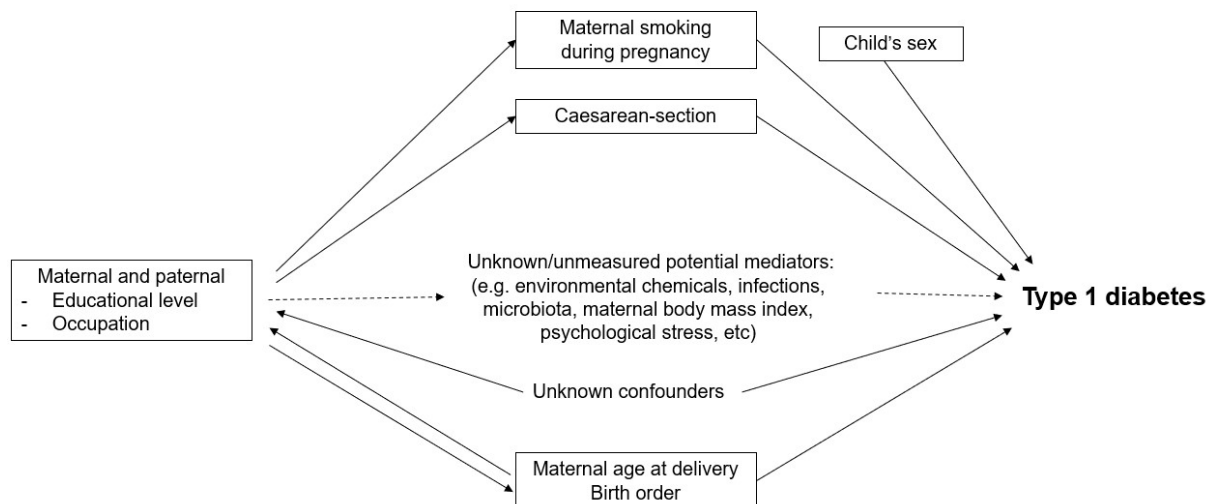


Figure S2. Simplified causal model used as basis for interpreting analyses

A conceptual model based on a priori knowledge and assumptions with necessary simplifications. Arrows represent assumed causal effects. Variables in solid boxes are adjusted for in our regression models. Maternal smoking was adjusted for in robustness analyses because it was only available in a subset. Although not shown in the figure, we also adjusted for calendar period, age and county of residence at birth in all models as explained in the methods section of the main text (and maternal type 1 diabetes in robustness analysis (Supplementary Table S4).

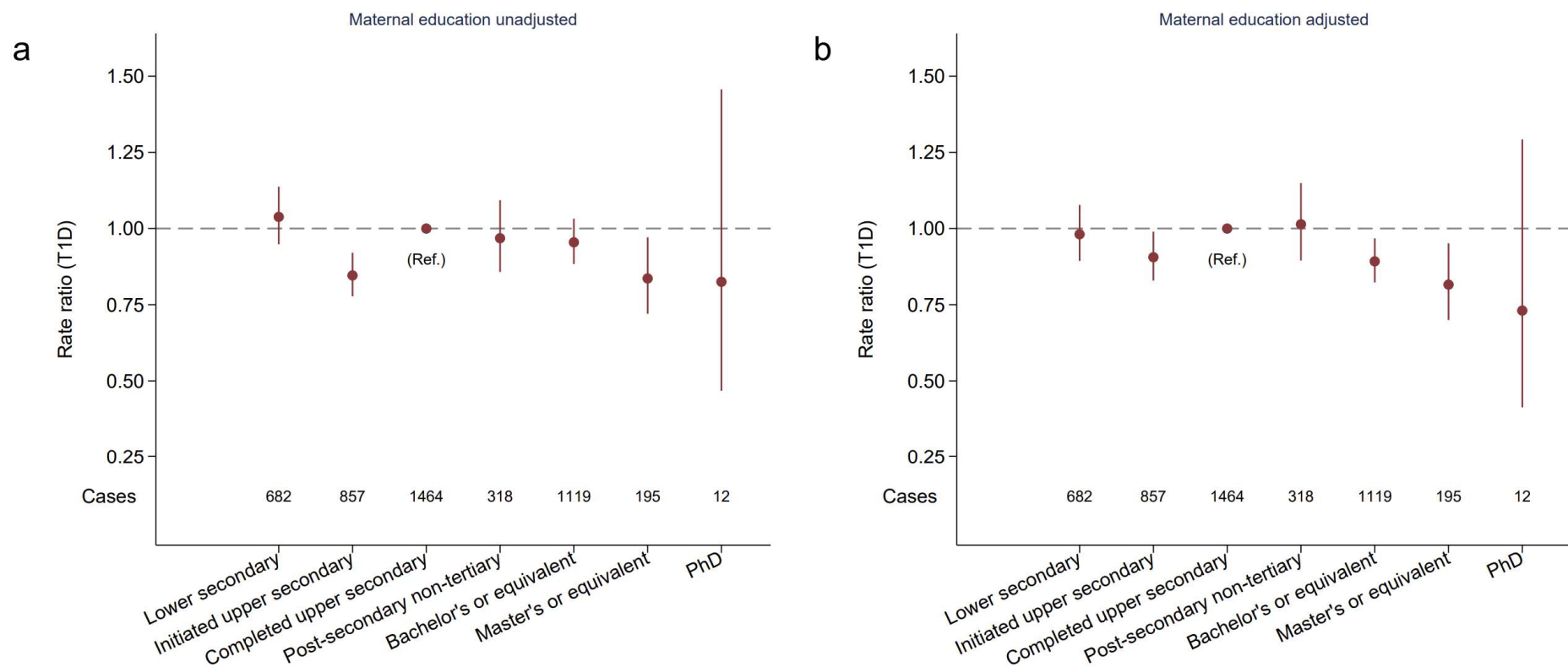


Figure S3. Maternal education and incidence of type 1 diabetes (T1D) before and after adjusting for covariates

a) Maternal education unadjusted and b) Maternal education adjusted for maternal age at delivery, parity, caesarean section, child's sex, county of residence, age and calendar period.

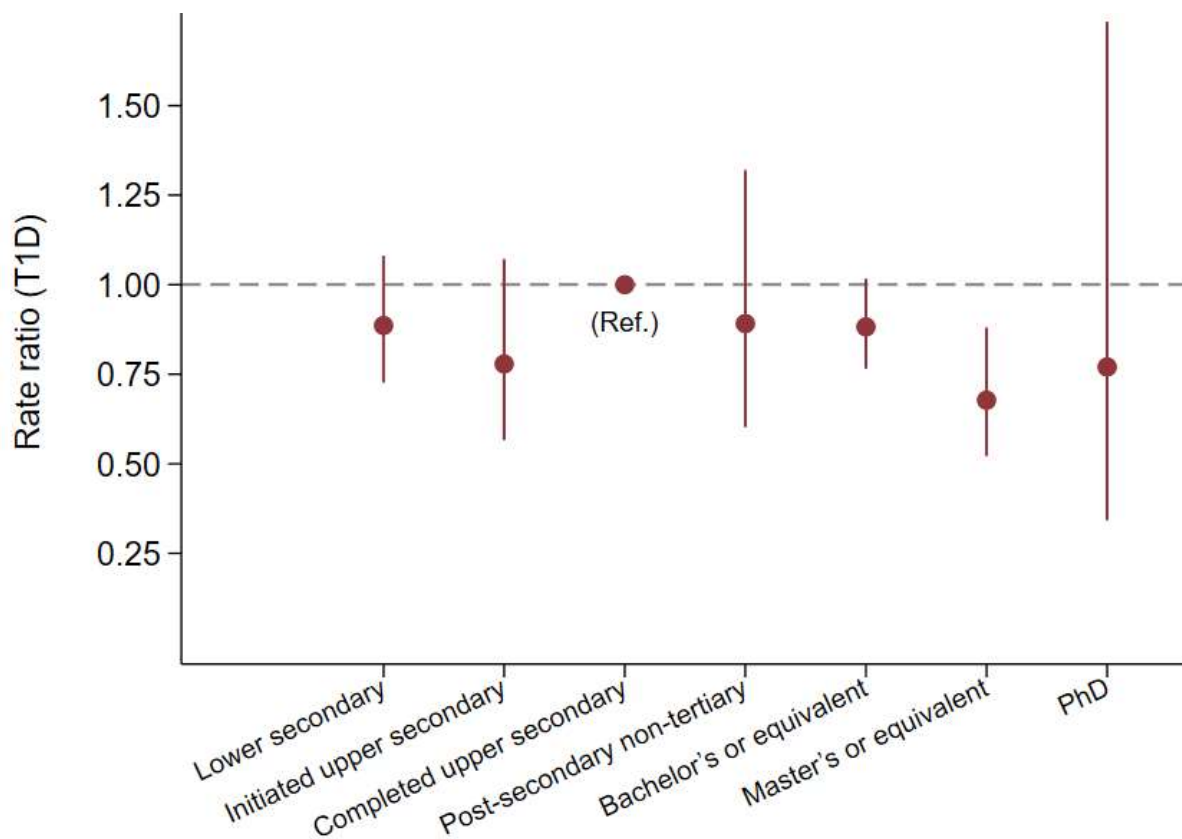


Figure S4. Influence of adjustment for maternal smoking in the analysis of maternal education and risk of type 1 diabetes

Information on maternal smoking was available for 81% of the births 1999-2013 (see detail characteristics in supplementary table S3). Incidence rate ratios adjusted for paternal age, parity, county of residence, child's sex and smoking. T1D: Type 1 diabetes.

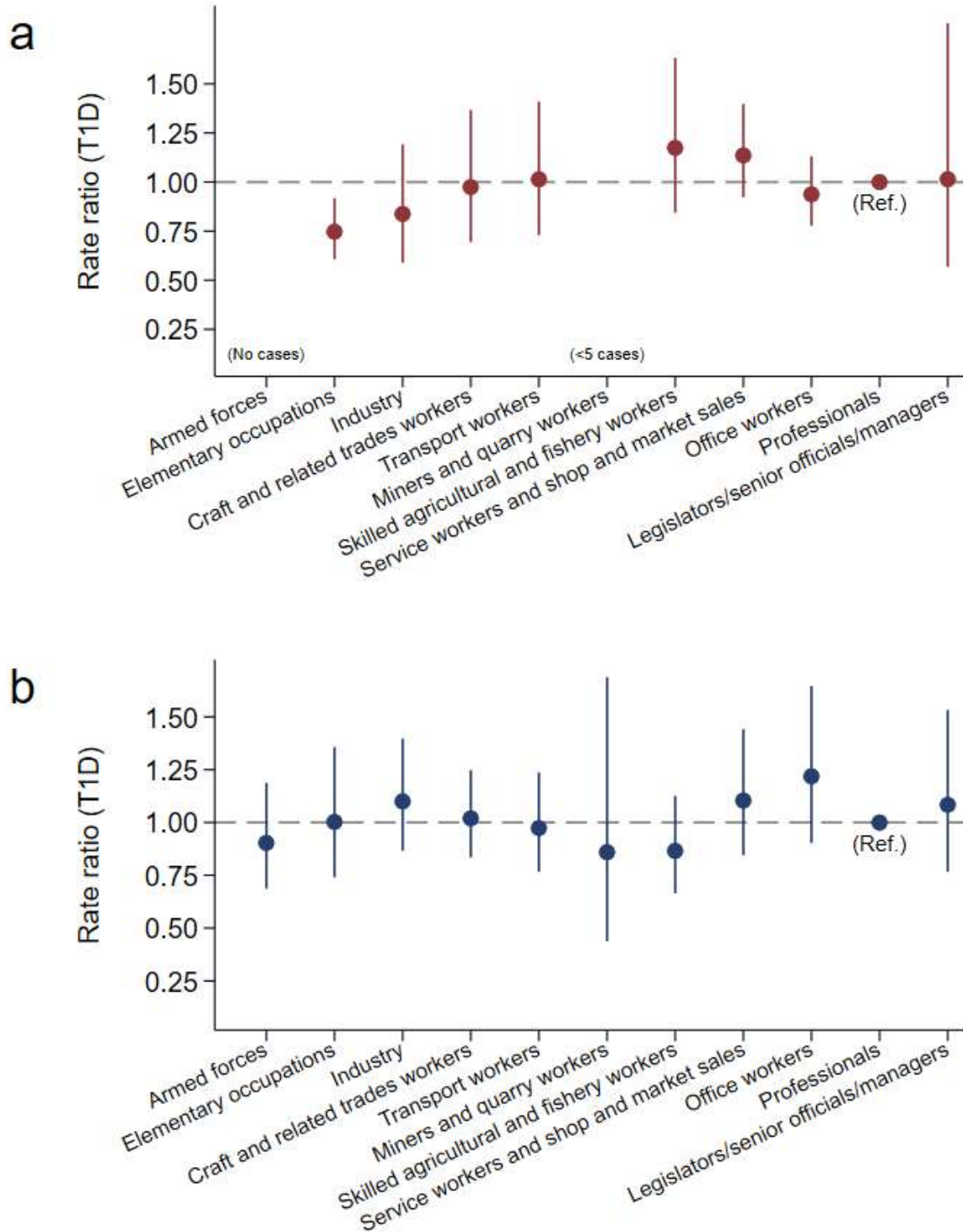


Figure S5. Influence of additional adjustment for education in the analysis of parental occupation and risk of type 1 diabetes

Likelihood ratio test (10 degree of freedom) $p=0.014$ for maternal occupation, likelihood ratio test=0.63 for paternal occupation. T1D: Type 1 diabetes.