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Use of health-care resources after gestational diabetes mellitus - A longitudinal case-control analysis

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Abstract

Aims: To analyse whether gestational diabetes mellitus (GDM) was associated with increases in health-care utilization after delivery. *Methods:* A longitudinal case-control registry-based study of 579 women with GDM delivered in 1995–2001. Two controls for each case were selected from the Swedish National Board of Health and Welfare, matched for year of birth, year of delivery, and municipality of residence. Data regarding health-care utilization was provided by the Patients' Administrative System in Skåne County, Sweden, covering the period from the years of delivery up to year 2009. *Results:* Women with previous GDM had higher mean number of contacts and total cost in the years after delivery as compared to controls, also when excluding utilization related to subsequent pregnancies and childbirth. By year 2009 31% of women with prior GDM were diagnosed with diabetes, compared to 1% of controls. Women diagnosed with diabetes were more likely to use health-care (odds ratio 14.22, 95% confidence interval 5.87–34.45) controlling for age and time since delivery, whereas cases not diagnosed with diabetes did not differ from controls. The average annual cost of health-care utilization was 101% higher ($p<0.001$) for women with diabetes 10 years after delivery compared to controls. *Conclusions:* GDM was associated with higher health-care utilization postpartum for women who had a diabetes diagnosis. The results call for implementation of structured programs to follow-up women with GDM postpartum for early detection of diabetes and effective management, which may have the potential for improved health and savings in health-care costs.

Key words: costs and cost analysis, health-care utilization, longitudinal registry-based data, previous gestational diabetes mellitus

Background

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of variable severity with onset or first recognition during pregnancy [1]. After delivery glucose tolerance usually reverts to normal, but women with GDM have a significant risk for subsequent development of type 2 diabetes [2, 3]. A cumulative incidence of 50% within 5 to 10 years postpartum has been shown [2].

In the County of Skåne in southern Sweden a general screening program for GDM was introduced in 1991, offering a 75 g oral glucose tolerance test (OGTT) to all pregnant women in week 28 of their pregnancy, as previously described [4]. A 2-h capillary blood glucose concentration of ≥9.0 mmol/L is regarded as diagnostic for GDM [5]. The incidence of GDM is increasing worldwide [6] and today affects around 2% of pregnant women in Skåne County [4], implying identification of almost 300 new women with predisposition for diabetes annually. Prospective studies indicate that it is possible to prevent or delay the onset of type 2 diabetes by modest weight loss through dietary changes and increased physical activity [7, 8], also in women with impaired glucose tolerance and a history of GDM [9]. All women with GDM in our area are advised to change their lifestyle after pregnancy, if necessary, and are likewise offered an OGTT one year after delivery. Women then diagnosed as having diabetes are referred to primary care for intervention, but aside from this no further actions are taken. On the basis of these routines we have previously reported a diabetes incidence of 9% after 1 year of delivery [10] and 30% after 5 years [11].

Type 2 diabetes is a chronic progressive disease leading to long-term complications that brings a considerable social and economic burden on healthcare resources [12–16].

Theoretically, large gains in terms of quality of life and savings in terms of need for health-care resources and production losses avoided for the society could be expected if the development of diabetes in women with GDM could be prevented or postponed. The aim of the present study was to analyse whether women, who had been diagnosed with GDM, also had higher use of health-care recourses during the subsequent 14 years after delivery compared to matched controls. An additional aim was to explore the effect of being diagnosed with diabetes after delivery on utilization.

Methods

Women with GDM delivered during 1995–2001 in Lund and Malmö, either participating in earlier studies or identified through diagnostic registers from the University Hospitals of Lund and Malmö (n=579), entered the study. No exclusion criteria were stated. Two controls (without diabetes diagnosis) for each case were selected from the Swedish National Board of Health and Welfare, matched for year of birth, year of delivery and municipality of residence in the delivery year (n=1131). For 17 cases it was not possible to identify more than one control.

An explorative register study with a descriptive, longitudinal case-control design was used to investigate annual data on the number of outpatient contacts, inpatient days and costs of care for cases and controls. The difference in utilization and cost between cases and controls after childbirth was considered to be a measure of the excess utilization and cost that could be attributed to GDM. Comparisons between cases and controls were made as regards total health-care utilization and health-care utilization excluding subsequent pregnancies and

childbirths, defined by having the main or second diagnosis with ICD code from group O or a diagnosis-related-group (DRG) code 370–77 or 382–84. Data regarding health-care utilization was provided by the Patients´ Administrative System in Skåne County (PASIS), Sweden, covering the period from the years of delivery up to year 2009. The reports included contacts (visits and telephone calls) in public and private primary care (acute or planned contacts with doctors, midwives, nurses, physiotherapists) and in- and outpatient care at hospitals (length of stay, main diagnoses, side diagnoses, code for DRG). Costs of care were calculated using Skåne Regional administrative prices by clinic and type of care. Personal identification numbers were removed before the data were delivered to the research team. Costs are given in nominal values of Swedish crowns in results based on calendar year. For analyses with reference to time since GDM, all costs were indexed to year 2009 costs using the Swedish health-care index (Statistikdatabasen; www.scb.se) and the average annual exchange rate for year 2009, SEK 100 = EUR 10.6213 (www.riksbanken.se).

Ethical approval was obtained from the Research Ethics Committee of the Medical Faculty, University of Lund, Sweden (Dnr 2009/571).

Statistical methods

Non-parametric Pearson χ^2 test of median values, t-test of mean values and Mann-Whitney-rank sum test were used for comparison of primary and outpatient contacts, inpatient days and cost [17]. Regression analyses controlling for the woman's age, time since delivery, and the interaction of case and time since birth were used to analyse cross-sectional and longitudinal data. Logistic regression was used to estimate the odds-ratio (OR) with 95% confidence interval (CI) for the probability of having a diabetes diagnosis in year 2009 (8 to 14 years after delivery). Random-effects logistic longitudinal regression was used to obtain OR with

95% CI for having at least some health-care utilization in a year after delivery using annual data 1998–2009. The excess cost of health-care utilization for cases was computed using longitudinal population-average generalized linear estimation using annual data 1998–2009 [18]. Longitudinal regression analyses were performed for data sorted by time since delivery.

Results

Data for publicly produced health-care were available for the years 1998–2009 and for privately produced health-care for the years 1999–2009. The number of contacts, number of inpatient days and the cost per year for cases and controls were analysed. Results presented below are based on health-care utilization starting the calendar year after the delivery and continuing up to maximum 14 years, except for Figures 1, panel a and b, where data before the year of delivery were included.

About eight out of ten women in the study had at least some health-care utilization each year. The difference between cases and controls was significant in years 1998–2001 (5-13 percentage units, $p<0.05$), but not later. By year 2009, between 8 and 14 years after childbirth, cumulatively 180/579 (31%) women with GDM had had at least one physician consultation or inpatient episode, where a diabetes diagnosis E10 or E11 (ICD 10 code) had been registered (Table I). The corresponding numbers in the control group was 13/1131 (1%). Logistic regression of risk of diabetes diagnosis after delivery showed a 12-fold increase in the risk for women with GDM 1–9 years after delivery (Table II). In year 2009, 10–14 years had passed since the delivery for 488 of the 579 women with GDM. For this group, the risk of diabetes was more than 50 times higher compared to women not exposed to GDM.

Table I shows the mean annual number of contacts in public and private care per person, the annual number of inpatient days and the annual total nominal cost for the period 1998–2009. Analysing single years, cases had more contacts each year ($p<0.001$ all years) and higher costs ($p<0.05$, except for years 2007–2009). Non-parametric test of medians revealed the same pattern of differences. Excluding costs for contacts and episodes related to subsequent pregnancy and childbirth diagnoses did not change the differences between cases and controls. Our study design implied that all women were followed at least 8 years after delivery. For women who gave birth in the 1990s, we had longer follow-up; 488 cases and 950 controls were followed at least 10 years; 274 cases and 532 controls were followed at least 12 years; and 63 cases and 123 controls were followed 14 years. Fourteen years after GDM and the delivery, the median age of women was 46 years old (interquartile range 42–51).

Cases and controls differed in mean number of inpatient days in 5/12 years (Table I). Results by random-effects logistic regression showed that it was, cases that were diagnosed with diabetes after delivery who were more likely than controls to have an inpatient episode; OR 2.74 (95% CI 2.09–3.61). Cases not diagnosed with diabetes after delivery did not differ from controls; OR 0.93 (0.75–1.17).

Organizing data by time since delivery rather than calendar time, cases and controls had an increase in health-care utilization in the year of delivery as expected and shown by the peak in costs in year 0 in Figure 2, panel a. Women diagnosed with GDM had higher mean number of contacts and total cost compared to controls in the year of delivery ($p<0.001$; $p<0.001$). The impact of potential further pregnancy and childbirth on health-care utilization and cost was

investigated by excluding contacts and stays where the main or second diagnosis had an ICD code from group O or DRG codes related to pregnancy or childbirth (Figure 2, panel b). The apparent peak in costs in the year of delivery was essentially removed as shown in Figure 2, panel b, and there was also a marginal reduction in mean costs in later years as costs for subsequent pregnancies were excluded. Mean costs for cases with a diabetes diagnosis were different from that of controls all years ($p<0.001$), while the mean costs for cases without a diabetes diagnosis were different from that of controls only in the first ($p<0.001$) and second year after the delivery ($p=0.03$).

Regression analyses on data on utilization not related to subsequent pregnancies showed that the probability of having at least some health-care utilization after delivery did not differ between cases without a diabetes diagnosis and controls; OR 1.18 (95% CI 0.92–1.50). Nevertheless, cases diagnosed with diabetes (ICD-10 E10 or E11) after delivery, were more likely to have some utilization OR 14.2 (95% CI 5.87–34.4) by random-effects logistic regression controlling for age and time since delivery. These results changed only marginally if utilization related to subsequent pregnancy and childbirth was included (corresponding OR 1.16 95% CI 0.91–1.47; and OR 13.7 95% CI 5.64–33.1).

There was an overall trend in less health care utilization over time after delivery. However, among women who had at least some health-care utilization in a year, annual costs were 61% higher for women who were diagnosed with diabetes after delivery ($p<0.001$) compared to women without diabetes diagnosis, controlling for age of the woman and time since delivery. Moreover, among women with at least some health-care utilization, annual costs increased by increasing time since delivery; for women without a diabetes diagnosis (+5%, $p<0.001$) and

for women with a diabetes diagnosis (+1%, p=0.11; the lack of statistical significance could be due to lack of power). The average annual cost of health-care utilization was 101% higher ($p<0.001$) for women with diabetes 10 years after delivery compared to controls. Noteworthy, there was no difference in the likelihood of having an additional pregnancy in subsequent years (OR 1.03, 95% CI 88–1.21 cases vs. controls).

Discussion

Analysing longitudinal data 1998–2009 on women who had experienced GDM during 1995–2001, we found that cases had significantly higher annual health-care utilization compared to controls after delivery, but only after they had been diagnosed with diabetes (type 1 or type 2) at a physician visit or inpatient stay. Moreover, women with GDM but no diabetes diagnosis in subsequent years did not differ from controls.

One strength of the analysis related to the study design, with decade long follow-up after GDM, including both women diagnosed with diabetes and those who were not. Another benefit of using registry based observational data, was that the analysis was based on health care resource use during the immediate years after the GDM diagnosis, i.e. before the diagnosis of diabetes and prior to the development of significant long-term complications. The case-control approach for the calculation of the excess cost in the case of diabetes appears to be a preferable method due to the complex relationship between diabetes and different co-morbidities [19, 20]. It cannot be assumed that medical care for diabetes necessarily corresponds to only the medical care registered under the diagnosis of diabetes. Therefore, all consumption of available resources was considered, diabetes related and non-diabetes related alike. By this approach, the costs for a (statistical) case with GDM and a diabetes diagnosis were twice costs of a control without GDM. This excess annual cost of diabetes corresponded to the costs of about ten physician visits in primary care or three diabetes team visits including physician at the hospital on year 2009 prices.

A major limitation with respect to costs not included in the study was the omission of indirect costs, such as loss of productivity and sick leave. The most recent cost-of-illness study based

on Swedish registry data in year 2005 calculated that the indirect costs (lost production due to morbidity, disability and premature mortality) accounted for 63% of total costs [16]. Another drawback is that data on drug consumption was not obtained. However, this is probably of less importance since drug costs for patients with type 2 diabetes have a minor impact on the total cost, and appear to have decreased, accounting for 7% of total direct costs in a study carried out in Sweden in 2004 [21] compared with 14% in 1998 [12].

Nearly all diabetes cost-of-illness studies conducted are prevalence-based, and estimate the cost of health-care during a limited period of time [14]. Complications and hospitalization arising from diabetes have been shown to account for the highest proportion of the cost of health-care [13, 15, 21–24]. Only a few studies have assessed the pattern of excess costs, or costs in populations with known dates of onset of the disease [14, 19, 20]. Using such an approach [19], the cost of medical care more than doubled during the first 8 years following the diagnosis of diabetes, and its recognition more than doubled the medical care expenditures. This is in line with the present findings showing an increase in the use of health-care resources in women with previous GDM, related to women diagnosed with diabetes after delivery.

The incidence figures of diabetes in women with GDM the years after delivery in the present study are in agreement with the figures previously reported from our region [10, 11], and by others [2], reaching a cumulative incidence of about 40% 14 years after delivery (Figure 2). We used a cumulative definition based on the first incidence of registered diabetes diagnosis in the longitudinal data, which may result in an underestimation as diabetes may not always be registered at consultations for other reasons. In addition, time to diagnosis could be

overestimated, but basing the definition on all physician and inpatient stays this risk was minimized.

Women with GDM had a higher number of outpatient contacts in the year of delivery which may be expected due to the extended care programmes during pregnancy offered to these women. Nevertheless, our data showed that the difference remained also after excluding costs of contacts and inpatient stays for diagnoses related to pregnancy and childbirth (Figure 2). It was also expected that a continuous growth in the use of medical resources would be observed during the years after delivery, but in fact, increasing time since delivery per se was associated with a reduced consumption of health-care when controlling for the woman's age. However, among women who had at least some health-care utilization in a year, women who were diagnosed with diabetes postpartum had an annual excess cost compared to those without a diabetes diagnosis, controlling for age and time since delivery.

Conclusions

The most important finding was the excess consumption of health-care postpartum in women with GDM, which could be related to women who had a diabetes diagnosis. Benefits of delaying the onset of diabetes after GDM would accrue to women who remain in better health, and to the health sector in terms of potential for savings in health-care costs. The results call for implementation of structured programs postpartum to follow-up women with GDM. Continuation of changes in lifestyle, initiated during pregnancy, together with annual follow-up glucose measurements to counteract and postpone the progression of the disease could be a cost-effective resource allocation.

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Conflicts of interest

None declared.

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Table I

Cumulative diabetes incidence, number of contacts in public and private care, number of inpatient days and annual total cost by calendar year for the period 1998–2009. Mean per person in the case group and in the control group for women 1–14 years after childbirth with GDM diagnosis.

Year	Cum. diabetes [1)]	Annual number of contacts			Inpatient days			Annual total cost (in SEK) [2)]		
		Per person			Per person			Per person		
	n (%)	Case	Control	p [3)]	Case	Control	p [3)]	Case	Control	p [3)]
		Mean (SEM)	Mean (SEM)		Mean (SEM)	Mean (SEM)		Mean (SEM)	Mean (SEM)	
1998	46 (17)	7.4 (0.6)	5.0 (0.3)	<0.001	1.5 (0.7)	0.6 (0.1)	0.097	11 123 (2408)	6843 (629)	0.027
1999	74 (20)	9.3 (0.6)	6.3 (0.4)	<0.001	0.7 (0.1)	0.7 (0.2)	0.954	10 206 (780)	7669 (731)	0.029
2000	110 (23)	10.2 (0.6)	6.6 (0.3)	<0.001	1.6 (0.4)	0.3 (0.0)	<0.001	15 431 (2106)	6615 (378)	<0.001
2001	123 (23)	10.6 (0.5)	7.0 (0.3)	<0.001	0.7 (0.1)	0.4 (0.1)	0.176	11 607 (806)	7571 (505)	<0.001
2002	134 (23)	11.6 (0.6)	7.6 (0.3)	<0.001	0.8 (0.1)	0.4 (0.1)	0.002	13 334 (1041)	7658 (499)	<0.001
2003	143 (25)	12.0 (0.6)	8.2 (0.4)	<0.001	0.9 (0.2)	0.5 (0.1)	0.030	14 428 (1314)	9042 (753)	<0.001
2004	153 (26)	12.1 (0.6)	8.6 (0.4)	<0.001	0.7 (0.2)	0.6 (0.2)	0.594	13 711 (1245)	9657 (745)	0.003
2005	158 (27)	11.5 (0.6)	8.2 (0.4)	<0.001	0.5 (0.1)	0.5 (0.2)	0.961	12 487 (1155)	8672 (747)	0.004
2006	162 (28)	11.1 (0.6)	8.3 (0.4)	<0.001	0.7 (0.2)	0.3 (0.0)	0.010	13 370 (1400)	9396 (667)	0.004
2007	165 (28)	10.9 (0.6)	8.6 (0.4)	<0.001	0.5 (0.1)	0.7 (0.2)	0.570	11 952 (1120)	12 321 (1531)	0.872
2008	170 (29)	12.3 (0.7)	8.5 (0.4)	<0.001	0.8 (0.3)	0.5 (0.2)	0.423	14 653 (1653)	11 379 (1138)	0.099
2009	180 (31)	8.4 (0.5)	6.5 (0.4)	0.003	0.4 (0.1)	0.3 (0.1)	0.011	14 790 (1373)	10 649 (918)	0.269

[1)] Cumulative number of women diagnosed with diabetes (ICD-10 code E10, E11) among cases. [2)] Nominal prices. [3)] P-values of two-sided t-tests of equal means.

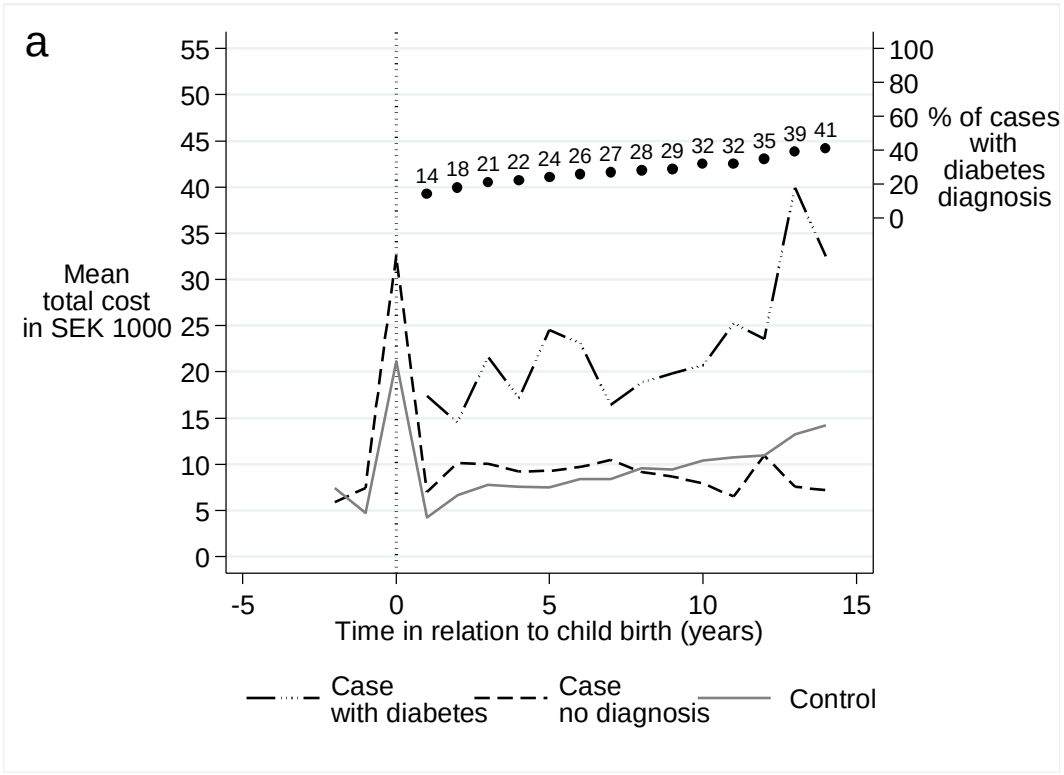
Table II.

Results by logistic regression of risk of having been diagnosed with diabetes[1)] at least once at physician contact or inpatient care episode after delivery up to year 2009 for women exposed to GDM and controls not exposed to GDM (N=1710) controlling for woman's age at delivery.

Variable	**OR[2)]**	**95% CI[3)]**
Time since delivery and exposure to GDM		
Control 1–9 years after delivery (Reference)	1.00	
Control 10–14 years after delivery	0.41	0.13–1.36
Woman exposed to GDM 1–9 years after delivery	11.80	3.87–35.95
Woman exposed to GDM 10–14 years after delivery	52.45	26.47–103.92

[1)] Defined by physician contact or inpatient stay with diagnosis E10 or E11 between 1 and 14 (maximum) years after delivery. [2)] OR odds-ratio. [3)] CI confidence interval

Figure 1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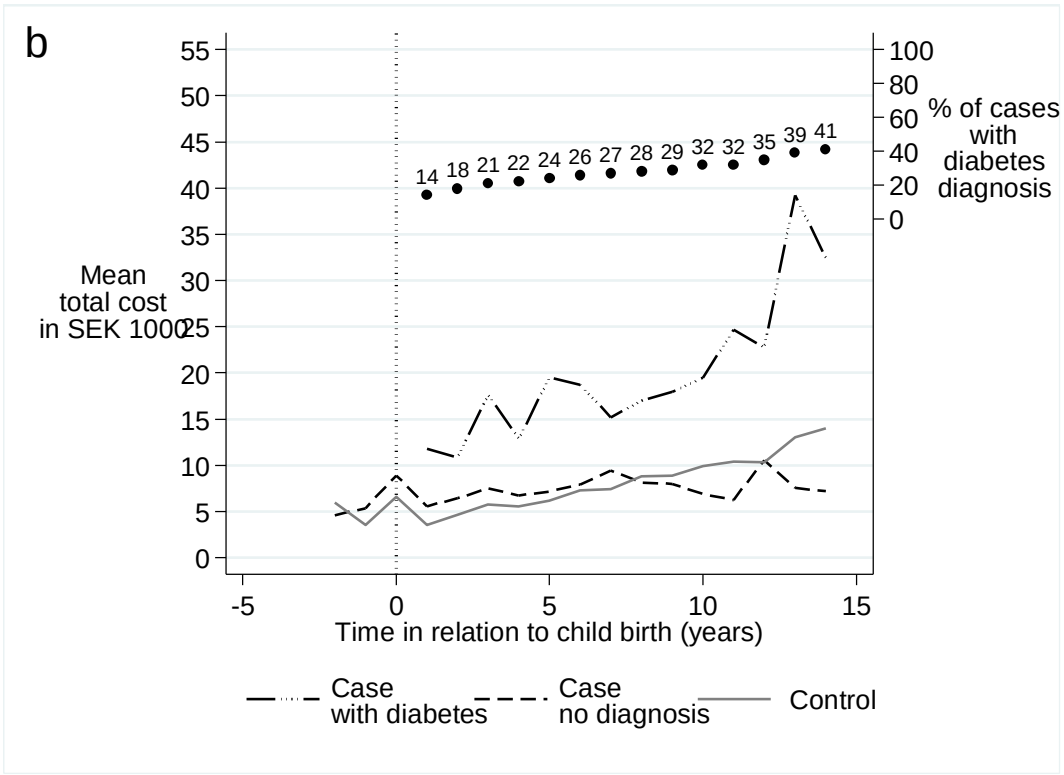
Time in relation to child birth (years)
Case
with diabetes
Case
no diagnosis
Control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Time in relation to child birth (years)
Case
with diabetes
Case
no diagnosis
Control

Figure caption

Figure 1

Mean annual total cost of outpatient and inpatient care per person (left axis) and percentage of cases diagnosed with diabetes after the delivery of the child (right axis) in relation to year of childbirth marked by large dots. Costs for cases diagnosed with diabetes after the birth of the child (dot-dashed black line); for cases *not* diagnosed with diabetes (dashed black line); and for controls (solid grey line). Panel (a) shows costs of all contacts and inpatient stays. Panel (b) shows costs where contacts and inpatient stays related to pregnancy and childbirth were excluded (main or second diagnosis ICD code from group O or DRG code 370–77 or 382–84).