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Perspectives in Practice

Demographics of Women With Type 1, Type 2 and Gestational Diabetes Attending a Diabetes and Pregnancy Clinic in 2000–2002, 2010–2012 and 2014–2016



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Key Messages

- The number of women being seen in endocrine and pregnancy clinic doubled over the time period of 2000–2016.
- Higher clinic use was associated with increased gestational diabetes mellitus and body weight as well as changes to oral glucose tolerance test criteria after 2013.
- A smaller increase in the number of women with type 2 diabetes was also noted, without any increase in weight in this population.

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Introduction

Diabetes mellitus (DM) during pregnancy can be either type 1 (T1DM), type 2 (T2DM) or gestational (GDM). The number of pregnancies complicated by T2DM and GDM is increasing (1–4). The obesity epidemic is one explanation for this observed increase, as the risks for T2DM and GDM are linked to excess body weight (5,6). Another potential factor behind increased clinic use may be changing GDM diagnostic criteria, the impetus for which came after the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) trial (7).

Stable referral practices and clinic structure in London, Ontario, offered a singular opportunity to document the demographic characteristics of pregnant women with diabetes. London is a southern Ontario city of 380,000 surrounded by small towns and farming communities. Women would expect to deliver in London if they lived within an hour of the centre, with some high-risk pregnant women coming farther for tertiary centre care. The

Endocrine and Pregnancy Clinic (EPC) at St Joseph's Health Care has provided outpatient pregnancy diabetes care for over 2 decades to all pregnant women in the referral area who have diabetes; EPC procedures and staff (dietitian, nurse educator and endocrinologists) have been consistent during this interval.

Over time, growing concern developed in the EPC around providing care to significantly increased numbers of women. It was of interest to us to interrogate the proportions and characteristics of EPC patients having each type of diabetes over time. A retrospective chart review was undertaken for EPC women with diabetes in 3 time intervals between 2000 and 2016 for documentation of type of diabetes, medication use, maternal body habitus measures and demographics.

Methods

After receiving Western University's Research Ethics board approval, EPC charts were reviewed for 3 time intervals,

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2000–2002, 2010–2012 and 2014–2016. These time periods were chosen as follows: interval 2000–2002, to provide baseline data; interval 2010–2012, documenting clinic population changes of the next decade; and interval 2014–2016, allowing for 1 year of physician adjustment to the new Diabetes Canada guidelines.

Charts were evaluated for type of diabetes (T1DM, T2DM, GDM), age, weight, body mass index of pregnancy, weight gain by last visit, year/week of DM diagnosis, DM medication use, antihypertensive medication use, frequency of insulin pump use, glycated hemoglobin (A1C) and oral glucose tolerance test (OGTT) used for GDM diagnosis. Categorization of women into T1DM or T2DM was done by usual clinical decision-making weighing elements of past history, age at diagnosis, body habitus, medication use, A1C results. The clinic practice was to order a monthly A1C for women with T1DM and T2DM. The first and last A1C available in clinic were documented.

Continuous results were analyzed by one-way analysis of variance; nonparametric results were analyzed by chi-square test, with $p < 0.05$ indicating clinical significance.

Results

The numbers of women with DM seen in the EPC were 408 in 2000–2002, 571 in 2010–2012 and 813 in 2014–2016. The total number of deliveries (women with and without DM) in London were 16,387 in 2000–2002, 16,855 in 2010–2012 and 16,236 in 2014–2016.

Results for women with GDM are summarized in Table 1. Over the 3 time periods, numbers and proportions of women with GDM rose significantly when compared with overall deliveries (1.8% initially, rising to 4.4% by 2014–2016) and, when compared with all women attending the EPC (72.8% initially, rising to 88.4% by 2014–2016). Although age and week of first visit were similar, weights at first visit were higher over time, but not significantly higher when comparing first and last visit. Oral medication use increased with time, whereas insulin use decreased. Choice of OGTT for women seen in 2014–2016 was as follows: 61% underwent the 50-g screen followed by a fasting 75-g load, and 39% had the fasting 75-g load only.

The results for women with T1DM are summarized in Table 2. The proportion of women with T1DM remained unchanged with time, representing <1% of deliveries. Insulin pump use increased by the second and third time intervals. A1C values were lowest in the first time period, but decreased significantly when comparing first to last visits within each time interval. A1C results for pump users vs nonusers did not differ within the time intervals assessed.

Results for women with T2DM are summarized in Table 3. Although the number of deliveries for women with T2DM increased

significantly by 2014–2016, the proportion of women with T2DM remained at <1% of all deliveries and represented <10% of all women seen in the EPC. Weight at presentation to clinic and weight gain were lower over time. More women were taking oral diabetic agents and fewer were taking insulin in the last time period. A1C values were significantly lower at the last visit of the first cohort, although A1C values by last visit were lower than at the first visit for all time periods.

Figure 1 summarizes the percentages of women with GDM, T1DM and T2DM in comparison to citywide deliveries.

Discussion

The present study is the first known report that documents the numbers and characteristics of women attending a Canadian EPC over an extended time interval. Numbers of women seen in a citywide EPC increased from 408 in 2000–2002 to 813 in 2014–2016 representing a doubling of patients seen, whereas the background number of citywide deliveries remained constant. The major determinant of the observed activity increase was increased numbers of women with GDM, although a small, but significant increase in women with T2DM was also noted.

Gestational diabetes

Women with GDM represented 4.4% of total deliveries and 88% of clinic patients by 2014–2016, an increase from 1.8% and 73%, respectively, in 2000–2002. These results follow the trends reported in United States wherein the prevalence of GDM increased from 3.71% in 2000 to 5.77% in 2010 (8), and which was documented to be 6% at one timepoint in 2016 (9). The slightly lower prevalence of GDM observed in our study could reflect any or all of differing population ethnicities, obesity rates along with access to universal health-care provision in Canada.

Prior to 2013, all local GDM diagnoses were made by the contemporary Diabetes Canada criteria of a 50 g screen followed by the fasting 75 g test with normal ranges 5.3/10.6/8.9 mM (10,11). However, in 2013, there were changes made to the GDM diagnostic criteria, as outlined in the Diabetes Canada Clinical Practice Guidelines (12): GDM diagnosis by the 50-g screening test followed by a fasting 75-g OGTT when needed remained the preferred choice while allowing for physician preference to use the HAPO diagnostic test of a single fasting 75-g OGTT. GDM diagnostic criteria were changed with abnormal results on the 75-g OGTT after 50-g screen and redefined as: fasting, 5.3 mmol/L; 1 hour, 10.6 mmol/L; and 2 hours, 9.0 mmol/L (instead of 5.3, 10.6 and 8.9 mmol/L, respectively). One abnormal glucose finding after the 75-g OGTT resulted

Table 1
Characteristics of women with gestational diabetes

	2000–2002	2010–2012	2014–2016	p
Citywide total deliveries	16,387	16,855	16,236	
GDM women vs total deliveries (n%)	297/1.8%	456/2.7%	719/4.4%	<0.001
Total number of women seen in EPC	408	571	813	
Women with GDM in EPC (n%)	297/72.8%	456/80.0%	719/88.4%	<0.001
Age (years)	33.1±5.6	32.8±5.2	33.3±5.0	NS
Weight at first visit (kg)	89.3±20.6	90.3±21.7	93.2±23.3	0.02
Weight at last visit (kg)	91.6±21.2	92.4±21.8	93.4±22.1	NS
Weight change at last visit (kg)	2.2±3.7	1.7±2.7	1.6±6.0	NS
Week of GDM diagnosis	27.8±5.4	28.3±5.19	28.2±5.2	NS
Antihypertensive use at first visit (n%)	4/0.8%	17/3.7%	25/3.5%	NS
Antihypertensive use at last visit (n%)	5/1.7%	13/2.8%	30/4.2%	NS
Oral DM medication use at first visit (n%)	2/0.7%	7/1.5%	6/0.8%	NS
Oral DM medication use at last visit (n%)	1/0.3%	4/0.9%	40/5.6%	<0.001
Insulin use at first visit (n%)	3/1.0%	16/3.5%	1/0.1%	<0.001
Insulin use at last visit (n%)	132/44.4%	176/38.6%	220/30.6%	<0.001

DM, diabetes mellitus; EPC, Endocrine and Pregnancy Clinic; GDM, gestational diabetes mellitus; NS, not statistically significant.

Table 2
Characteristics of women with type 1 diabetes

	2000–2002	2010–2012	2014–2016	p
Citywide total deliveries	16,387	16,855	16,236	
Women with type 1 DM vs total deliveries (n/%)	59/0.36%	60/0.36%	75/0.47%	NS
Total number of women seen in EPC	408	571	813	
Women with type 1 DM seen in EPC (n/%)	59/14.5%	60/10.5%	75/9.2%	0.02
Age (years)	28.8±5.6	31.5±4.9	29.0±5.5	0.01
Years of DM diagnosis	14.6±8.9	15.6±8.2	15.7±8.6	NS
Weight at first visit (kg)	74.6±15.8	74.2±14.5	74.9±18.5	NS
Weight change by last visit (kg)	9.8±5.8	8.7±7.7	11.0±9.8	NS
Gestational week at first visit	14.1±8.4	13.3±6.5	11.5±6.5	NS
Pump use at first visit (n/%)	6/10.2%	26/43.3%	31/41.3%	<0.001
Pump use at last visit (n/%)	6/10.2%	25/41.7%	33/44.0%	<0.001
Antihypertensive use at first visit (n/%)	1/1.7%	1/1.7%	2/2.7%	NS
Antihypertensive use at last visit (n/%)	5/8.5%	6/10.0%	5/6.7%	NS
A1C at first visit (%)	6.9±1.4%	7.2±1.3%	7.6±1.3%	0.03
A1C at last visit (%)	6.5±0.9%	6.7±1.1%	7.1±1.1%	0.03

A1C, glycated hemoglobin; DM, diabetes mellitus; EPC, Endocrine and Pregnancy Clinic; NS, not statistically significant.

in a GDM diagnosis (as opposed to 2 abnormal results). A 75-g OGTT was recommended for any 50-g screen result of 7.8 to 11.0 mmol/L (as opposed to GDM being diagnosed whenever the 50-g screen result was ≥ 10.3 mmol/L).

Acceptance of the HAPO diagnostic criteria has been controversial (13–16), with strong and varied opinions across the global medical community. A major concern associated with switching to the HAPO diagnostic criteria was the potential for a doubling of GDM prevalence, leading to a significant increase in both personal and health-care system costs (17–19). Since HAPO testing was chosen by referring physicians for only 39% of women in the 2014–2016 cohort, GDM diagnostic criteria change is only one part of the increased prevalence puzzle, with population obesity likely representing the major driving force in the latter time period.

Oral medication (metformin exclusively) use increased, whereas insulin use decreased in the final time interval, consistent with increasing physician comfort with metformin after the Metformin in Gestational Diabetes trial (20). Although there was no significant increase in age or week of presentation to clinic, GDM women weighed more at clinic presentation by the third time interval, which is consistent with the increasing obesity in the population.

Type 1 diabetes

Women with T1DM represented <1% of total deliveries, and only 10% to 14% of EPC patients (the proportionate change was driven by the increased GDM prevalence). There was a

nonsignificant 27% increase in women with type 1 DM over the years, consistent with a Scottish registry analysis of 814,000 births wherein T1DM pregnancies increased 44% between 1998 and 2013 (21).

Years of DM diagnosis, week of first clinic visit, weight at first visit and weight gain were unchanged, although the mean age in 2010–2012 was slightly higher, an inexplicable discrepancy, and due to the small cohort size may have been secondary to chance alone.

Insulin pump use increased by 2010–2012 and remained steady in 2014–2016, which was coincident with onset of provincial pump funding. Data on continuous monitoring were not collected, but anecdotally very few women used the device either by choice or lack of coverage.

Despite increased use of insulin pumps with time, A1C results were lowest at first clinic visit in the earliest time cohort. However, data were not available for preconceptual A1C or counselling to allow for any helpful inferences about prepregnancy care approaches. Still, although the mean initial A1C increased over time, EPC women in all 3 time periods did achieve an improvement in glycemic control by the end of pregnancy.

Type 2 diabetes

Women with T2DM also represented <1% of total deliveries, although they accounted for 9% to 12% of EPC patients (the proportion again driven by the GDM numbers). Over time, there

Table 3
Characteristics of women with type 2 diabetes

	2000–2002	2010–2012	2014–2016	p
Citywide total deliveries	16,387	16,855	16,236	
Type 2 DM vs total deliveries (n/%)	52/0.32%	55/0.33%	78/0.48%	0.02
Total number of women seen in EPC	408	571	813	
Women with type 2 DM seen in EPC (n/%)	52/12.7%	55/9.6%	78/9.6%	NS
Age (years)	32.5±6.1	33.6±5.2	33.8±5.4	NS
Years of DM diagnosis	4.6±5.3	5.0±5.2	4.6±5.8	NS
Weight at first visit (kg)	101.0±18.9	91.9±23.3	91.2±24.9	0.04
Weight at last visit (kg)	110.3±19.6	100.0±25.2	97.2±28.0	0.02
Weight change at last visit (kg)	9.1±7.9	9.5±7.7	7.7±5.4	NS
Gestational week at first visit	15.6±8.7	15.0±7.1	15.5±8.8	NS
Oral agent use at first visit (n/%)	17/32.7%	20/36.4	33/42.3%	NS
Oral agent use at last visit (n/%)	1/1.9%	1/1.8	23/29.5%	<0.001
Insulin use at first visit (n/%)	12/23.1%	20/36.4	16/20.5%	NS
Insulin use at last visit (n/%)	45/86.5%	44/80.0	46/59.0%	<0.001
Antihypertensive use at first visit (n/%)	5/9.6%	4/7.3%	5/6.4%	NS
Antihypertensive use at last visit (n/%)	4/7.7%	1/1.8%	8/10.2%	NS
A1C at first visit (%)	6.6±1.6%	7.2±1.8%	6.8±1.5%	NS
A1C at last visit (%)	5.6±0.8%	6.4±1.2%	6.2±1.0%	<0.01

A1C, glycated hemoglobin; DM, diabetes mellitus; EPC, Endocrine and Pregnancy Clinic; NS, not statistically significant.

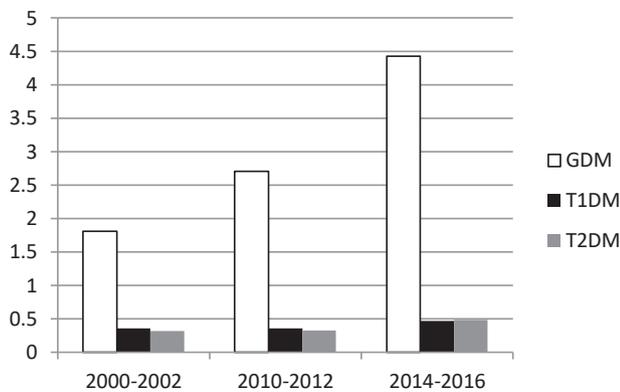


Figure 1. Percentages of women with gestational diabetes mellitus (GDM), type 1 and type 2 diabetes mellitus (T1DM, T2DM) over time compared with city-wide deliveries.

was a significant 50% increase in women with T2DM, which is lower than reported in the Scottish registry (21). An American database audit of prepregnancy diabetes (type 1 and 2 diabetes together) reported a 0.9% prevalence in 2016 (8), and an increase from 0.65% in 2000 to 0.89% in 2010 (22), consistent with the present findings. Years of DM diagnosis, week of first clinic visit and age were no different across time. Considering the prevalence of population obesity, it had been expected that women with T2DM would weigh more with time, but surprisingly the weights were approximately 10 kg lower in the second and third time cohorts compared with the first cohort. This finding could suggest women were being diagnosed with T2DM at lower weights, or possibly entering pregnancy with intentionally lower weights. Data were not collected on preconception medication use, so it can only be speculated that women used fewer thiazolidenediones (the associated cardiovascular controversy beginning in 2007); used more weight-neutral drugs, such as sitagliptin (released in 2008), or used more weight-loss-enhancing drugs (liraglutide released in 2010, canagliflozin released in 2014) for T2DM in the latter time periods compared with 2000–2001.

Weight gain by last EPC visit was lower in the 2014–2016 cohort, perhaps due to less use of insulin, or possibly better adherence to lifestyle advice. All A1C values decreased by the last visit, even though more women were taking oral agents (metformin) in 2014–2016. Increased use of metformin reflects not only the increased comfort of the EPC physicians with this medication, but also an observation that family practitioners, obstetricians and the women themselves appeared to be increasingly unconcerned about metformin use in pregnancy.

Limitations

This study has some limitations. The results reported across all time periods do not capture GDM women who had only one abnormal glucose value to whichever 75-g OGTT was administered (pre-2013: always done after a 50-g screen; post-2013: done after the screen or de novo). Clinical resource considerations dictated that this cohort of women be referred for dietary advice alone, and were not seen in the EPC unless subsequent blood glucose (BG) results rose over targets on more than one occasion—in general, ~7% of these women devolve higher BGs and come to the EPC. All women with an elevated fasting BG done with either form of 75-g OGTT were always seen in the EPC due to concerns that diet alone could not alter overnight insulin resistance. Therefore, the number and characteristics of women with presumed “impaired glucose tolerance” of pregnancy as it was called in 2000–2002 and 2010 to 2012 are unknown, as are the number and characteristics of “GDM”

women from 2012 to 2014, defined by one elevated BG after OGTT. However, although no comments can be made about this cohort with presumably a milder form of GDM, results reflect consistency across all time intervals as results are compared for women with an elevated fasting glucose on 75-g OGTT, or 2 elevated glucose results on the 75-g OGTT.

Further, the ethnicity and social economic status (SES) of women in the populations may have had an impact on study outcomes but patient ethnicity and SES were not part of the clinical chart documentation available. Also, data were not collected on women with diabetes who failed to come to clinic; there were no patients known to have other types of diabetes, such as monogenic diabetes; nor were the numbers of fertility clinic-assisted pregnancies recorded. Although of potential interest, details of preconception care of women with T1DM and T2DM were not available. Further, some women with T2DM were taking neither insulin nor oral agents at their first visit but numbers of women with good glucose control on lifestyle treatments alone vs those who had stopped all medication as soon as they had conceived were not captured on the clinical charts.

In conclusion, the number of women attending the diabetes and pregnancy outpatient clinic doubled between 2000 and 2016, predominantly due to a 142% increase in women with GDM, who manifested higher body weights over time. Women with T1DM did not increase significantly in number, although the number of women seen with T2DM increased with time despite not being more overweight. While women with T1DM and T2DM represented <20% of EPC patients by 2016, the small increases in their numbers along with their potentially more complex needs (including insulin pump assistance) in comparison to GDM women, may still increase health utilization.

While provision of care to pregnant women with diabetes is clinically important, it is also associated with consumption of system resources including time, space and personnel. Physicians and health-care administrators may need to consider the financial demands associated with increasing rates of clinic traffic as outlined in this report when allocating clinical resources, with a particular focus on serving the needs of women with GDM.

Author Disclosures

Conflicts of interest: None.

Author Contributions

R.M., S.L., J.L.M. and T.J. conceived the trial, supervised data collection and critiqued the successive versions of the manuscript. P.K., L.C., K.A. and E.B. completed the data collection and contributed to the statistical analysis. R.M. and P.K. wrote the successive versions of the manuscript.

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