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ORIGINAL ARTICLE

Impact of Covid-19 on rates of gestational diabetes in a North American pandemic epicenter

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Abstract

Aims We assessed the impact of Covid-19 on gestational diabetes rates in Quebec, the pandemic epicenter of Canada.

Methods We conducted a population-based study of 569,686 deliveries in Quebec between 2014 and 2021. We measured gestational diabetes rates in wave 1 (March 1, 2020–August 22, 2020) and wave 2 (August 23, 2020–March 31, 2021), compared with the prepandemic period. We used interrupted time series regression to assess changes in gestational diabetes rates during each wave, and log-binomial regression models to estimate adjusted risk ratios (RR) and 95% confidence intervals (CI) for the association of the pandemic with gestational diabetes. We identified the types of patients that contributed to the change in gestational diabetes rates using Kitagawa's decomposition.

Results Gestational diabetes rates were higher during the first (13.2 per 100 deliveries) and second waves (14.3 per 100 deliveries) than during the prepandemic period (12.4 per 100 deliveries). Risk of gestational diabetes increased both in wave 1 (RR 1.05, 95% CI 1.02–1.09) and wave 2 (RR 1.14, 95% CI 1.10–1.18), compared with the prepandemic period. However, most of the increase in gestational diabetes rates was driven by low-risk women without Covid-19 infections who were socioeconomically advantaged, had no comorbidity, and were 25–34 years of age.

Conclusions Gestational diabetes rates increased during the pandemic, mainly among women traditionally at low risk of hyperglycemia who did not have Covid-19 infections. Sudden widespread changes in screening or lifestyle can have a large impact on gestational diabetes rates in a population.

Keywords Covid-19 · Gestational diabetes · Interrupted time series analysis · Pandemics · Pregnancy · Socioeconomic factors

Introduction

Covid-19 is associated with preeclampsia, preterm birth, and stillbirth [1, 2], but the relationship with gestational diabetes is less clear. Gestational diabetes occurs in 8–17% of

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pregnancies and is one of the most common pregnancy complications [3]. Recent data suggest that rates of gestational diabetes increased during the pandemic in several countries [1, 4, 5], a concerning trend because women with gestational diabetes are at risk of type 2 diabetes and cardiovascular disease after pregnancy [3]. However, studies have not investigated the underlying reasons for the increase in gestational diabetes rates during the pandemic.

Understanding why the rate of gestational diabetes changed is complex as societal changes brought on by the pandemic may have influenced trends. Prevalence of risk factors for gestational diabetes, such as obesity and depression [3, 6], may have increased among women who became pregnant during the pandemic. Social distancing and lockdowns may have affected diets or sedentary behaviors associated with an increased risk of hyperglycemia [7–9]. Lockdowns may have increased stress levels due to isolation and lack of social support during pregnancy [9]. The age, socioeconomic status, or other characteristics of women who became pregnant may also have shifted [10]. In some regions, the challenge of accessing contraception during lockdowns may have increased the number of unintended pregnancies, particularly among women of lower socioeconomic backgrounds who are at higher risk of gestational diabetes [11]. Detection of gestational diabetes also depends on screening methods [12], which may have changed during the pandemic. Our objective was to identify the main factors that contributed to the change in gestational diabetes rates during the first and second waves of the pandemic in Quebec. Quebec was the Canadian epicenter during the first year of Covid-19, with one of the highest mortality rates and strictest lockdowns in the world [13, 14].

Methods

Study population

We analyzed a cohort of 569,686 pregnant women who delivered in hospital between January 1, 2014 and March 31, 2021 in Quebec, Canada. This time span covers the six-year period before the pandemic as well as the first and second waves. We extracted deliveries from the Maintenance and Use of Data for the Study of Hospital Clientele registry which contains discharge summaries for all hospitalizations in the province [15]. Delivery discharge summaries provide clinical information from the prenatal dossier for the first, second, and third trimesters of pregnancy. We did not include women with preexisting diabetes as they cannot be diagnosed with gestational diabetes. We also restricted the cohort to deliveries at 28 weeks of gestation or later, when most pregnant women have undergone glycemic screening [16].

Exposure measurement

The main exposure measure was delivery during the pandemic versus prepandemic period. In this study, the pandemic period extended from March 1, 2020 to March 31, 2021. The pandemic was officially declared in Quebec in March 2020, shortly after the first confirmed case of Covid-19 was reported on February 27, 2020 [17]. We divided pandemic exposure based on the wave in which delivery occurred, including wave 1 from March 1, 2020 to August 22, 2020 and wave 2 from August 23, 2020 to March 31, 2021. Wave 1 includes a brief trough period in the months of July and August when Covid-19 circulation was low.

We analyzed patients with SARS-CoV-2 infections to better understand the infectious versus societal pathways linking the pandemic with gestational diabetes. Hospitals in Quebec screened women at admission for Covid-19 from the start of the pandemic [18]. Hospitals also collected data on past SARS-CoV-2 infections. We therefore knew if women had an active Covid-19 infection around the time of delivery or resolved infection from earlier in pregnancy. Active infections included confirmed and suspected cases, whereas resolved infections included patients with a history of Covid-19 or symptoms of long Covid-19. However, active Covid-19 infection at the time of delivery cannot be a cause of gestational diabetes, as this condition is usually diagnosed in the second trimester. Resolved infections from the first or second trimester provide more support for a causal link between Covid-19 and gestational diabetes. We identified pregnant women with active (U07.1, U07.2) and resolved (U07.4, U07.5) infections using the 10th Revision of the International Classification of Diseases (ICD-10).

Gestational diabetes

The main outcome measure was gestational diabetes (ICD-10 O24.8). Before the pandemic, pregnant women were screened for hyperglycemia using a routine one or two-step approach between 24 and 28 weeks of pregnancy [16]. With the one-step approach, fasting glucose levels were measured before a 75-g glucose challenge, followed by glucose measurements one and two hours later. Gestational diabetes was diagnosed if blood glucose levels were $\geq$ 5.1 mmol/L (91.8 mg/dL) fasting, $\geq$ 10.0 mmol/L ($\geq$ 180 mg/dL) one-hour post-challenge, or $\geq$ 8.5 mmol/L ($\geq$ 153 mg/dL) two-hour post-challenge. With the two-step approach, women were screened using a 50-g glucose challenge and diagnosed with gestational diabetes if glucose levels were $\geq$ 11.1 mmol/L ($\geq$ 199.8 mg/dL) one-hour post-challenge. Women with glucose levels between 7.8–11.0 mmol/L (140.4–198.0 mg/dL) underwent a 75-g glucose tolerance test.

During the pandemic, an optional strategy was introduced allowing for screening with plasma hemoglobin A1c (HbA1c) and random glucose measurements [19]. An HbA1c ≥ 5.7% (39 mmol/mol) or random glucose level ≥ 11.1 mmol/L (≥ 199.8 mg/dL) was considered gestational diabetes [19]. Sensitivity of the optional strategy was, however, low (25%, 95% CI 10–49%), while specificity was high (96%, 95% CI 86–99%) [19].

Women who delivered at the start of wave 1 were screened with the one- or two-step approach before the pandemic started, whereas women who delivered later in the first wave were tested during the pandemic transition. Women who delivered during wave 2 were all screened during the pandemic.

Covariates

We examined several factors that could influence gestational diabetes rates, such as age (< 25, 25–34, ≥ 35 years), parity (0, 1, ≥ 2 previous deliveries), comorbidity including obesity, dyslipidemia, or hypertension (yes, no), socioeconomic disadvantage (quintiles from least to most disadvantaged), and place of residence (rural, urban, unspecified). We derived the level of socioeconomic disadvantage from a composite index of the proportion of individuals with low education, unemployment, and low income in neighborhoods [20].

Statistical analysis

We calculated rates of gestational diabetes before and during the pandemic for women with and without SARS-CoV-2 infection. We also calculated the expected gestational diabetes rate had the average trend before the pandemic continued into 2020 and 2021.

We used three analytical methods to analyze the relationship between the pandemic and gestational diabetes: (1) interrupted time series regression to assess the impact of pandemic waves on changes in the rate of gestational diabetes; (2) multivariable regression to determine the association of pandemic waves with gestational diabetes adjusted for patient characteristics; and (3) Kitagawa decomposition to identify patient characteristics that drove the change in gestational diabetes rates over time.

Interrupted time series

Interrupted time series analysis is a quasi-experimental design that measures the impact of sudden events on an outcome [21]. As the pandemic had a sudden onset in March 2020, interrupted time series analysis is well-suited to determine the effect of the pandemic on rates of gestational diabetes [21].

We began the time series in January 2014, the year after Diabetes Canada updated gestational diabetes screening and diagnosis guidelines [12]. These guidelines remained in place for the duration of the study. We evaluated changes in monthly rates of gestational diabetes using an autoregressive model to account for seasonality and correlation between months. There were two interruptions in the time series, one at the start of the first wave and the other at the start of the second wave. We determined the immediate change in the gestational diabetes rate at the start of each wave and during the remainder of follow-up.

Multivariable regression

We employed log-binomial regression models to estimate risk ratios (RR) and 95% confidence intervals (CI) for the association of the pandemic with risk of gestational diabetes, compared with the prepandemic period. For this analysis, we used a narrower prepandemic period (August 23, 2019 to February 29, 2020) that was closer in length to each wave. We also measured the association of active or resolved SARS-CoV-2 infections with gestational diabetes, relative to no infection. We adjusted the models for maternal age, parity, comorbidity, socioeconomic disadvantage, and place of residence.

Decomposition of rates

We used Kitigawa decomposition to identify specific patient characteristics that drove the change in gestational diabetes rates during the pandemic. Two factors can influence a rate: a rate can increase if (1) the *number of cases increases* in a high-risk subgroup of women, or (2) the *number of pregnancies increases* in a subgroup with an already elevated rate [22]. Kitagawa decomposition splits these factors into parts, which when summed, equal the total increase in the rate of gestational diabetes. Kitagawa decomposition identifies subgroups of women responsible for the increase in gestational diabetes rates over time [22].

We performed Kitagawa decomposition for several patient characteristics, including maternal age, comorbidity, SARS-CoV-2 infection, and socioeconomic disadvantage. To do so, we first computed the overall difference in the gestational diabetes rate between wave 1 and the prepandemic period. For each patient characteristic, we then computed the portion of the increase that was due to a change in the number of diabetes cases versus a change in the total number of pregnancies in a subgroup. We repeated the decomposition for the comparison of wave 2 with the prepandemic period.

We analyzed the data in SAS v9.4 (SAS Institute Inc., Cary, NC). We used anonymized data, and received an ethics waiver from the review board of our institution.

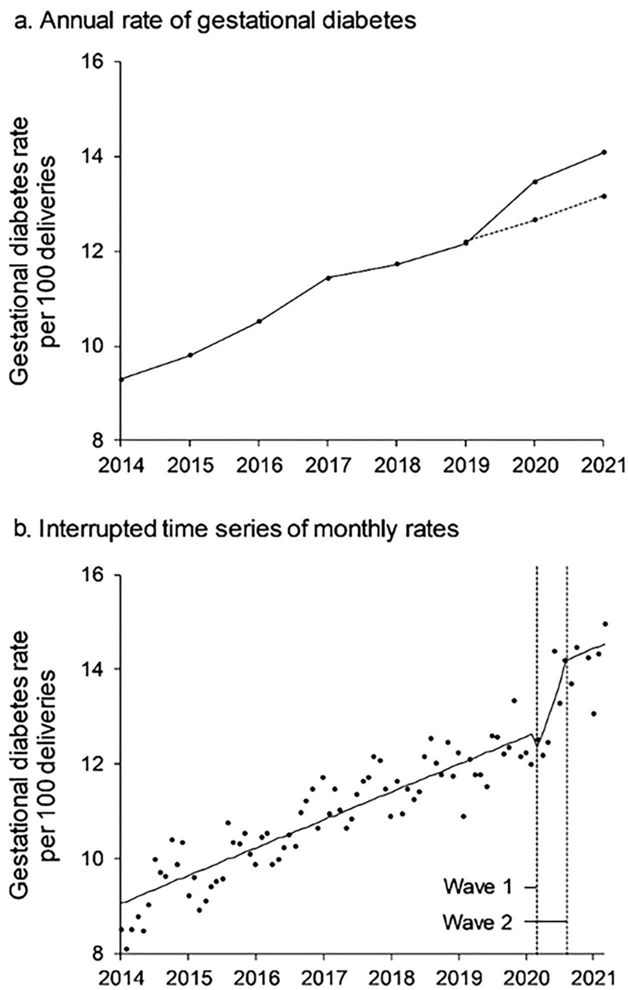

Fig. 1 Trends in rates of gestational diabetes among deliveries ≥ 28 weeks of gestation, Quebec, Canada, 2014–2021. Panel a: Solid line represents the annual rate of gestational diabetes from 2014 to 2021. Dashed line represents the expected rate had the change during the pandemic equaled the average annual change between 2014–2019. Panel b: Dots represent monthly rates of gestational diabetes per 100 deliveries. Left vertical line marks the start of wave 1 (March 2020); right vertical line marks the start of wave 2 (August 2020). Results of interrupted time series regression indicated that the rate of gestational diabetes in the prepandemic period increased by 0.05 cases per 100 deliveries every month (p-value < 0.0001). In the first month of wave 1, the rate decreased by 0.58 cases per 100 deliveries (p-value 0.27) before increasing by 0.32 every month during the remainder of wave 1 (p-value 0.04). In the first month of wave 2, the rate increased by 0.49 cases per 100 deliveries (p-value 0.39) and continued to increase by 0.05 cases per 100 deliveries every month to the end of the study (p-value 0.58)

Results

The rate of gestational diabetes increased both before and during the pandemic (Fig. 1). Between 2014 and 2019, rates increased an average of 0.6 percentage points annually. The increase in 2020 was, however, twice as high as expected. As a result, 13.5% of pregnancies were affected by gestational diabetes instead of an expected 12.7%.

Interrupted time series analysis nevertheless indicated that the rate of gestational diabetes decreased abruptly the first month of the pandemic (Fig. 1). The decrease was followed by a steep increase during the remainder of wave 1 (0.32 for every 100 deliveries per month) and the first month of wave 2 (0.49 for every 100 deliveries per month). During the remainder of wave 2, the increase slowed to 0.05 for every 100 deliveries per month, the same rate at which gestational diabetes had been increasing prior to the pandemic.

When we focused on the six months preceding the pandemic, 12.4% of deliveries were affected by gestational diabetes (Table 1). In contrast, 13.2% of deliveries were affected in wave 1 and 14.3% in wave 2. Gestational diabetes rates were greater in women ≥ 35 years, with comorbidity, and higher socioeconomic disadvantage. During wave 1, rates increased in all women, although the increase was greatest for women without a SARS-CoV-2 infection. During wave 2, rates continued to increase for all women, especially women with active and resolved infections.

Risk of gestational diabetes was elevated during the pandemic even after adjustment for maternal characteristics (Table 2). Overall, women were 10% more likely to have gestational diabetes during the pandemic compared with beforehand (RR 1.10, 95% CI 1.07–1.13). During wave 1, women with no infection had a greater risk of gestational diabetes relative to the prepandemic period (RR 1.05, 95% CI 1.02–1.09); however, women with active SARS-CoV-2 infection did not have an increased risk (RR 0.95, 95% CI 0.60–1.51). During wave 2, women with resolved (RR 1.21, 95% CI 0.93–1.57), active (RR 1.38, 95% CI 1.09–1.74), and no infection (RR 1.14, 95% CI 1.10–1.18) all had an increased risk of gestational diabetes.

Kitagawa's decomposition indicated that most of the increase in gestational diabetes rates in the first and second waves was due to a rise the number of cases in uninfected women and women aged 25–34 years (Table 3). In wave 2, the rate of gestational diabetes increased by 2.00 percentage points overall, with 1.80 of the percentage points due to women with no infection. Women of 25–34 years led to a 1.37 percentage point increase in the rate, partly due to a greater number of deliveries in this age group. Women who were the most socioeconomically advantaged led to

Table 1 Rate of gestational diabetes stratified by pandemic wave and maternal characteristics

	No. deliveries (no. gestational diabetes)			Gestational diabetes rate per 100 deliveries		
	Active Covid-19	Resolved Covid-19	No infection	Active Covid-19	Resolved Covid-19	No infection
Wave[a]						
Prepandemic						
6 years prior	0 (0)	0 (0)	488,565 (52,912)	–	–	10.8
6 months prior	0 (0)	0 (0)	40,376 (4,996)	–	–	12.4
Wave 1	117 (15)	2 (0)	36,994 (4,865)	12.8	–	13.2
Wave 2	268 (50)	209 (38)	43,531 (6,236)	18.7	18.2	14.3
Age, years						
< 25	47 (5)	25 (3)	14,210 (1,381)	10.6	12.0	9.7
25–34	243 (37)	129 (17)	80,279 (9,348)	15.2	13.2	11.6
≥ 35	95 (23)	57 (18)	26,412 (5,368)	24.2	31.6	20.3
Parity						
0	179 (32)	98 (19)	59,172 (7,003)	17.9	19.4	11.8
1	112 (17)	69 (13)	40,480 (5,389)	15.2	18.8	13.3
≥ 2	94 (16)	44 (6)	21,249 (3,705)	17.0	13.6	17.4
Comorbidity[b]						
Yes	35 (14)	28 (9)	10,163 (3,260)	40.0	32.1	32.1
No	350 (51)	183 (29)	110,738 (12,837)	14.6	15.8	11.6
Socioeconomic disadvantage						
Low	65 (8)	30 (3)	20,369 (2,160)	12.3	10.0	10.6
Low-moderate	49 (5)	29 (9)	22,499 (2,735)	10.2	31.0	12.2
Moderate	73 (12)	47 (10)	22,779 (2,972)	16.4	21.3	13.0
High-moderate	69 (13)	44 (6)	23,408 (3,255)	18.8	13.6	13.9
High	111 (23)	52 (10)	24,524 (3,992)	20.7	19.2	16.3
Place of residence						
Rural	21 (6)	16 (0)	22,153 (2,781)	28.6	–	12.6
Urban	353 (59)	191 (38)	95,807 (12,981)	16.7	19.9	13.5
Total	385 (65)	211 (38)	120,901 (16,097)	16.9	18.0	13.3

[a]Prepandemic (six years prior: January 1, 2014–February 29, 2020; six months prior: August 23, 2019 to February 29, 2020); Wave 1 (March 1, 2020–August 22, 2020); Wave 2 (August 23, 2020–March 31, 2021)

[b]Obesity, dyslipidemia, and preexisting hypertension

a 0.19 percentage point increase in the rate, in part due to a greater number of deliveries. Women with the greatest socioeconomic disadvantage also contributed more cases, but their impact was offset by fewer deliveries. In both waves, women without comorbidity contributed more to the increase in gestational diabetes rates than women with comorbidity.

Discussion

This study of half a million pregnancies suggests that gestational diabetes rates increased in Quebec over the course of the first two waves of the pandemic. The increase was greater than expected compared with preexisting secular trends. Wave 2 was associated with a greater risk of gestational diabetes than wave 1, and women with and without SARS-CoV-2 infections all had elevated risks. Results indicated that the increase in gestational diabetes rates was driven by uninfected women aged 25–34 years, of higher socioeconomic status, and who had no comorbidity. Rates increased because of a greater number of gestational diabetes cases, and to a lesser extent, a greater number of pregnancies in these demographic groups. As these groups are normally at low risk for gestational diabetes, the results suggest that the increase may have occurred because of pandemic-related changes in external factors such as screening or lifestyle.

Trends in gestational diabetes during the pandemic are poorly understood. Previous studies have mainly focused on women hospitalized for Covid-19 during pregnancy, mostly reporting that women with gestational diabetes were more likely to test positive for Covid-19 [2, 23, 24]. Time trends

Table 2 Association between pandemic waves, Covid-19 infection, and risk of gestational diabetes

	Risk ratio (95% CI)	
	Unadjusted	Adjusted[a]
Time period		
Prepandemic, 6 months prior	Reference	Reference
During pandemic	1.11 (1.08 – 1.15)	1.10 (1.07 – 1.13)
Waves 1 and 2		
Prepandemic	Reference	Reference
Wave 1 active Covid-19	1.04 (0.65 – 1.66)	0.95 (0.60 – 1.51)
Wave 1 no infection	1.06 (1.02 – 1.10)	1.05 (1.02 – 1.09)
Wave 2 active Covid-19	1.51 (1.17 – 1.94)	1.38 (1.09 – 1.74)
Wave 2 resolved infection	1.47 (1.10 – 1.96)	1.21 (0.93 – 1.57)
Wave 2 no infection	1.16 (1.12 – 1.20)	1.14 (1.10 – 1.18)
Wave 1 only		
Active Covid-19	0.97 (0.61 – 1.56)	0.89 (0.56 – 1.41)
No infection	Reference	Reference
Wave 2 only		
Active Covid-19	1.30 (1.01 – 1.67)	1.22 (0.97 – 1.53)
Resolved infection	1.27 (0.95 – 1.69)	1.06 (0.82 – 1.38)
No infection	Reference	Reference

[a]Adjusted for maternal age, parity, comorbidity, socioeconomic disadvantage, and place of residence

were not examined, except in a rare number of countries [1, 4, 5]. In Italy, gestational diabetes rates increased from 9% in 2019 to 13.5% by July 2020 [1]. In the UK, the prevalence of gestational diabetes increased by 33.8% after June 2020 [4]. A cross-sectional study of 250,000 births in the USA found that the increase in risk of gestational diabetes became most apparent in July 2020 [5].

These trends align with the increase in gestational diabetes we found toward the end of wave 1 that continued into wave 2. Italy, the UK, the USA, and Quebec all had similar lockdown periods [1, 4, 5, 17]. For women delivering toward the beginning of wave 2, this period overlapped with the beginning or middle of pregnancy when risk of insulin resistance begins [3, 25]. Lockdowns in this period could have affected gestational diabetes rates by impacting diets and exercise habits of women [7–9], as well as increasing stress levels and mental health problems [1, 4, 26]. Previous studies have shown that women have a higher risk of gestational diabetes following natural disasters such as hurricanes and earthquakes [25, 27]. In China, pregnant women who spent the most time in lockdown had the highest risk of gestational diabetes [25].

The pandemic may have also led to changes in screening, following early reports that Covid-19 was associated with severe maternal morbidity in women with gestational diabetes [2, 24]. Physicians may have screened patients more vigilantly out of concern for obstetric morbidity. To reduce the number of visits to a testing center, some physicians may have switched to one-step screening, which tends to have greater sensitivity than the two-step approach [12]. However, it is unlikely that optional screening with HbA1c and random glucose measurements increased the detection of gestational diabetes as sensitivity of this approach is low. Studies have estimated that up to 82% of women with gestational diabetes screened with this method would be missed [28].

It is also unlikely that SARS-CoV-2 infections had a measurable impact on gestational diabetes rates. Our results indicate that women with active, resolved, and no infection all had an increased risk of gestational diabetes. This pattern aligns with a Swiss case–control study that found no association between the timing of Covid-19 infection and the prevalence of gestational diabetes among infected women [29].

Large changes in demographic patterns did not explain the rise in gestational diabetes rates either. Changes in the number of pregnancies in different demographic groups made only a small contribution to the increase in gestational diabetes. Changes in the number of women with risk factors such as older age or socioeconomic disadvantage did not contribute. Instead, Kitagawa composition demonstrated that the rise was due to a greater number of cases among women normally at low risk of gestational diabetes, including women with socioeconomic advantage, younger age, and no comorbidity. The findings suggest that improved screening or changes in stress levels, diet, and physical activity in women at low risk of gestational diabetes were the most important factors driving the increase in gestational diabetes during the pandemic.

This study had limitations. A relatively small number of women tested positive for Covid-19 during wave 1, which limited our power. We did not have information on the timing of resolved Covid-19 infections, which prevented us from determining if there was a causal association between Covid-19 and gestational diabetes. We had information on waves 1 and 2, but could not determine if gestational diabetes rates continued to increase in subsequent waves. We could not confirm the method used for gestational diabetes screening, which may have varied temporally or geographically. However, it is unlikely that the optional approach was widely used. We did not have data on potential confounders such as maternal ethnicity, prepregnancy weight, and gestational weight gain, although prior studies have found that increases in gestational diabetes rates occurred independent of these factors [1, 4, 25].

This population-based study of more than half a million women found that gestational diabetes rates increased during the first two waves of the pandemic in Quebec, mainly due to an increase in the number of cases among women traditionally at low risk of hyperglycemia without Covid-19 infections. The results suggest that the increase most likely occurred through pandemic-related changes in lifestyle or

Table 3 Kitagawa decomposition of factors that led to the increase in gestational diabetes rates in the first and second waves compared with prepandemic[a]

	Wave 1			Wave 2		
	Portion of increase due to a rate change	Portion of increase due to a change in number of deliveries	Total percentage point increase in rate	Portion of increase due to a rate change	Portion of increase due to a change in number of deliveries	Total percentage point increase in rate
SARS-CoV-2 infection						
Active	0	0.04	0.04	0.01	0.08	0.09
Resolved	–	–	–	0.03	0.09	0.11
No infection	0.78	−0.04	0.73	1.94	−0.14	1.80
Total	0.78	0.00	0.78	1.97	0.02	2.00
Maternal age, years						
<25	0.03	0.01	0.04	0.18	−0.04	0.14
25–34	0.43	0.04	0.47	1.18	0.19	1.37
≥35	0.37	−0.10	0.27	0.74	−0.25	0.48
Total	0.82	−0.05	0.78	2.10	−0.10	2.00
Comorbidity						
Yes	−0.02	0.23	0.22	0.28	0.57	0.85
No	0.64	−0.08	0.56	1.35	−0.20	1.15
Total	0.63	0.15	0.78	1.63	0.37	2.00
Socioeconomic disadvantage						
Low	0.03	0.02	0.05	0.18	0.01	0.19
Low-moderate	0.28	0.01	0.30	0.42	0.05	0.47
Moderate	0.12	0.03	0.15	0.43	0.05	0.47
High-moderate	−0.01	−0.02	−0.03	0.36	0.01	0.37
High	0.30	−0.03	0.27	0.55	−0.10	0.46
Total	0.79	−0.02	0.78	2.02	−0.03	2.00

[a]Waves 1 and 2 are each compared to the 6 months prior to the pandemic (August 23, 2019 to February 29, 2020). Gestational diabetes rates increased by 0.78 percentage points in wave 1 and 2.00 percentage points in wave 2. These increases are broken down into two components, including (1) the percentage increase attributable to a change in the actual gestational diabetes rate, and (2) the percentage increase attributable to a change in the number of deliveries in a group of women. A positive percentage change leads to an increase in the gestational diabetes rate, while a negative change leads to a decrease in the rate. The sum of all components for any given characteristic equals the overall increase in the gestational diabetes rate. For example, in wave 2, the sum of each component for comorbidity (0.28 + 1.35 + 0.57 + -0.20) equals 2.00, the overall percentage point increase in the rate

screening and underscore how sudden changes in such characteristics can have widespread effects on gestational diabetes rates in a population.

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Authors' contribution NA, SQW, JHP, AA, and JC conceived and designed the study. JC analyzed the data, with input from NA, JHP, and AA. NA, SQW, UVU, JHP, AA, and JC helped interpret the results. UVU, JC, and JHP drafted the manuscript, and NA, SQW, ND, CQ, AL, and TML revised it for important intellectual content. NA had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

Data availability The data that support the study findings are available from the Quebec Statistics Institute following standard access procedures (https://statistique.quebec.ca/research/#/demarche/etape-par-etapee).

Code availability (https://statistique.quebec.ca/research/#/demarche/etape-par-etapee) The code used to run the analysis can be accessed from the corresponding author upon request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval This is an observational study using anonymized data. The University of Montreal Hospital Research Ethics Committee has confirmed that ethical approval is not required and has waived review.

Informed consent Due to the anonymized nature of the data, informed consent to participate in the study and to publish the results was not required.

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