Published in final edited form as:

JACC Adv. 2024 April ; 3(4): . doi:10.1016/j.jacadv.2024.100907.

Association of the Early COVID-19 Pandemic With Gestational Diabetes in the U.S. 2018-2021

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Gestational diabetes (GDM) is one of the most frequent complications of pregnancy and is associated with adverse outcomes including elevated risk of total and cardiovascular mortality.[1] Prior to the pandemic, the incidence of GDM increased by 30% from 2016 to 2020.[2] The COVID-19 pandemic (and its related policies, eg, shelter-in-place) was associated with increases in psychosocial stressors, food insecurity, and physical inactivity, which may have uniquely affected dysglycemia risk in pregnancy.[3] Therefore, this study aimed to examine if the onset of the COVID-19 pandemic was associated with changes in the incidence rate of GDM in the United States.

METHODS

Data on pregnant individuals aged 15 to 44 years with a singleton first live birth between 2018 and 2021 were obtained from the National Center for Health Statistics. We excluded those with prepregnancy diabetes and missing GDM status for the primary analysis. GDM was recorded on the birth certificate by the professional attendant (eg, doctor or midwife) at birth.

We calculated monthly incidence rates per 1,000 live births and used a quasi-experimental study design with interrupted time series analysis to estimate the association of the onset of the pandemic with GDM incidence. We selected a delivery date at the end of May 2020 a priori as the cutoff point based on when second-trimester GDM screening is expected to occur: before or after the onset of the pandemic in March 2020. We used individual-level data and applied logistic regression to compare GDM incidence before and after the predetermined cutoff point, adjusting for individuals' age, state of residence, and race and ethnicity, which is a social construct representing lived experiences and is based on self-

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report. The logistic regression equation is shown below, where $cutoff$ is a dummy variable based on an individual's month of birth (=1 if born after May 2020); $Month$ is a continuous variable based on month of birth and is centered at May 2020; and β_{0s} denotes state-specific intercepts to account for differences in state-level policies in response to COVID-19.

$$\begin{aligned} logit(\Pr[GDM = 1 \mid Cutoff, Month, Age, Race, State]) \\ = (\beta_0 + \beta_{0s}) + \beta_1 Cutoff + \beta_2 Month \\ + \beta_3 Cutoff * Month + \beta_4 Age + \beta_5 Race \end{aligned}$$

We estimated the: 1) change (average marginal effect) in incidence rate at the cutoff; 2) monthly change in incidence rates before (January 2018-May 2020) and after (June 2020-December 2021) the cutoff; and 3) excess cases of GDM after the cutoff using previously published methodology.[4] To rule out seasonal or alternate temporal effects on GDM incidence, falsification testing was performed with May 2019 as an alternate cutoff point. This timepoint, 1 year prior to the primary cutoff point, was selected as it would not be expected to be associated with changes in GDM incidence. This study was deemed exempt by the Northwestern Institutional Review Board due to the use of deidentified, public-access data.

RESULTS

A total of 5,487,386 nulliparous individuals with singleton births were included. Data on GDM status missingness increased over the study period from 8% in 2018 to 14% in 2021 ($P < 0.01$). The incidence rate of GDM increased from January 2018 to December 2021 (56-73 per 1,000 live births) (Figure 1). The adjusted change in the incidence rate of GDM at the cutoff (ie, intercept) was 6.81 (95% CI: 5.46-8.15) per 1,000 live births. Trends in monthly incidence rates (ie, the slope of the lines) were significantly different before and after the cutoff, from 0.23 (95% CI: 0.17-0.29) per 1,000 live births per month from January 2018 to May 2020 to 0.01 (95% CI: −0.11 to 0.14) per 1,000 live births per month from June 2020 to December 2021. Based on the observed changes, we estimated 11,078 (95% CI: 10,165-11,991) excess cases between June 2020 and December 2021 attributed to the increase of GDM incidence at cutoff and the subsequent stabilized trend. There was no significant change in GDM incidence at the alternate cutoff for falsification testing or a significant difference in monthly trends before and after the alternate cutoff.

DISCUSSION

In this nationwide study of pregnant individuals in the United States, GDM incidence significantly increased following the onset of the COVID-19 pandemic. However, despite the higher absolute GDM incidence during the pandemic, the rate of monthly change declined during the pandemic. Limitations include the potential for miscoding of GDM on birth records. However, National Center for Health Statistics represents the most robust source available for nationwide surveillance. Second, interruptions in GDM screening due to the pandemic have been reported. We observed higher rates of missing data on GDM status in our sample during the pandemic period, which could lead to underestimation or overestimation of GDM incidence. The higher rates of missing data may also explain the decline in the rate of change during the pandemic. Third, data are not available on the timing of GDM diagnosis, which may have preceded the onset of the pandemic in some individuals. However, this would likely bias toward the null as well. In conclusion, the onset of the pandemic was associated with a significantly higher GDM incidence rate. Although GDM incidence was increasing prior to the onset of the pandemic, the abrupt increase and relatively stabilized trend after the cutoff point were associated with >11,000 excess cases of GDM over a 19-month period. These data extend and expand upon single-center studies that demonstrated higher GDM rates following the onset of the pandemic.[5] These findings underscore the need for ongoing surveillance to determine if these increases in GDM are sustained and whether they are associated with a greater burden of adverse maternal or neonatal outcomes.

Acknowledgments

This work was supported in part by National Heart, Lung, and Blood Institute grant R01HL161514. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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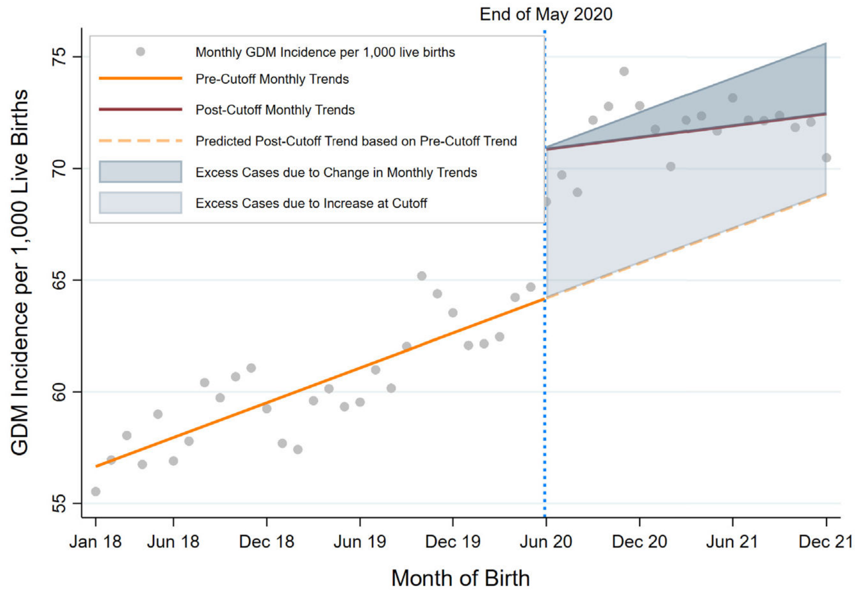

Monthly trend in pre-pandemic period (Jan 2018 – May 2020)	Change in incidence at cutoff	Monthly trend in early pandemic period (Jun 2020 – Dec 2021)	Difference in monthly trend between the two periods
AME per 1,000 live births per month (95% CI)	**AME per 1,000 live births (95% CI)**	**AME per 1,000 live births per month (95% CI)**	**AME per 1,000 live births per month (95% CI)**
0.23 (0.17-0.29)	6.81 (5.46-8.15)	0.01 (-0.11 to 0.14)	-0.22 (-0.32 to -0.12)
	Excess incidence due to increase at cutoff (95% CI)	**Excess incidence due to change in monthly trends (95% CI)**	**Total excess incidence (95% CI)**
	14,738 (14,362- 15,114)	-3,660 (4,615-2,706)	11,078 (10,165-11,991)

figure 1. Trends in Monthly Incidence Rate of Gestational Diabetes Among Pregnant Individuals With a Singleton, First Live Birth in the United States From 2018 to 2021: An Interrupted Time Series Analysis

The sample includes 5,487,386 pregnant individuals aged 15 to 44 years with a singleton first live birth after excluding those with prepregnancy diabetes and missing gestational diabetes status between 2018 and 2021 in the United States. Each dot represents the observed monthly incidence rate of gestational diabetes per 1,000 live births. The blue dotted vertical line visualizes the cutoff point: end of May 2020. The marginal trends in monthly gestational diabetes incidence are based on a logistic regression model adjusted for birthing individuals' age, race and ethnicity, and state-level fixed effects. The table in bottom panel shows average marginal effects per 1,000 live births and 95% CIs based on robust standard errors clustered around the state of residence. AME = average marginal effect; GDM = gestational diabetes.