Association Between Diabetes and Perinatal Depression Among Low-Income Mothers

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Postpartum depression affects approximately 10% to 12% of new mothers during the first 2 to 6 months after birth.1 While the prevalence of depression is similar in pregnant, postpartum, and nonpregnant women, onset of new depression is higher during the perinatal period.2,3 Untreated antenatal and postpartum depression can have long-lasting negative effects on the woman, the mother-child relationship, child development, the marital relationship, and the mental health of the affected woman's partner.4-7 Risk factors for postpartum depression include pregravid history of depression, interpersonal conflict and violence, stressful life events, lack of emotional, social, or financial support, difficult pregnancy or delivery, and fetal or neonatal health problems.8-12 However, many risk factors remain unknown or poorly understood. Identifying women at high risk for depression is important for both clinical care and policy decisions.

In an effort to better target and manage the health of pregnant women and new mothers, there is an emerging interest in the association between diabetes during pregnancy and postpartum mental health.13 Prior studies have established an association between diabetes and depressive disorders in general adult populations.14 There are several plausible biological and psychosocial mechanisms that could explain a potential association, including the effects of hyperglycemia and insulin on the thyroid and stress axis, as well as the psychological burden of managing a chronic disease during pregnancy and the postpartum period.15-17 Approximately 2% to 9% of pregnancies are complicated by diabetes.18 Diabetes during pregnancy is associated with both maternal and neonatal risks and complications.19,20 To date, research has examined several facets of the relationship between diabetes and depression among new mothers, showing the role of diabetes treatment in improving neonatal and maternal health outcomes.16 but also indicating that depression may be a barrier to postpartum weight loss.21 However, we know of no prior research that has characterized the association be-

Context  Perinatal depression affects at least 10% to 12% of new mothers, and diabetes complicates up to 9% of pregnancies. Prior research shows a higher rate of major depression among individuals with diabetes.

Objective To examine the association between diabetes and depression during pregnancy and the postpartum period among a sample of low-income women.

Design, Setting, and Patients Retrospective cohort study using data from New Jersey’s Medicaid administrative claims database of 11,024 women who gave birth between July 1, 2004, and September 30, 2006, and who were continuously enrolled in Medicaid for 6 months prior to delivery and 1 year after giving birth.

Main Outcome Measures Multivariate logistic regression was used to assess the association between prepregnancy diabetes or gestational diabetes and perinatal depression. Depression was defined as an International Classification of Diseases, Ninth Revision, diagnosis for depression or a prescription drug claim for an antidepressant medication, and diabetes was defined as having a diabetes diagnosis or filling a prescription for a diabetes medication. Both measures were assessed during the 6 months prior to and up to 1 year following delivery.

Results In the sample of women who gave birth, 15.2% (n=100) with prepregnancy or gestational diabetes and 8.5% (n=886) without diabetes were depressed during pregnancy or postpartum. After adjusting for age, race, year of delivery, and gestational age at birth, women with diabetes compared with those without diabetes had nearly double the odds of experiencing depression during the perinatal period (odds ratio, 1.85; 95% confidence interval, 1.45-2.36). Women with diabetes and no prenatal indication of depression (n=62, 9.6%) had higher odds than their counterparts without diabetes (n=604, 5.9%) of receiving a postpartum depression diagnosis or taking an antidepressant medication in the year following delivery (odds ratio, 1.69; 95% confidence interval, 1.27-2.23).

Conclusion Prepregnancy or gestational diabetes was independently associated with perinatal depression, including new onset of postpartum depression, in our sample of low-income new mothers.

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between preexisting diabetes and depression among pregnant women and new mothers. Therefore, the purpose of this study was to examine the association between diabetes and depression in the perinatal period in a sample of low-income women. In addition, we considered potential differential effects of particular types of diabetes (gestational diabetes or insulin-dependent diabetes) on the outcomes of interest, and distinguished the effect of diabetes on new onset of depression during the postpartum period.

**METHODS**

**Data**

Data for this study came from deidentified New Jersey Medicaid administrative records, which include eligibility and enrollment information, as well as claims for visits, procedures, and prescription medications. Analysis of the data required linking administrative records with claims data using a unique study identification number. However, these data do not include any personal identifying information.

**Study Population**

The study population included all women who gave birth in New Jersey between July 1, 2004, and September 30, 2006, whose deliveries were covered by fee-for-service Medicaid, and who were continuously enrolled in New Jersey's Medicaid program (either fee-for-service or managed care plans) for the period extending from at least 6 months prior to delivery through 1 year after giving birth. Study follow-up ended 1 year after delivery for each woman in the sample. As such, claims from January 1, 2004, through October 31, 2007, are used in the analysis.

Women who were dually eligible for both Medicare and Medicaid were excluded due to the potential for incomplete utilization data. The study population included mothers whose annual income is less than 115% of the federal poverty line (or about $41,000 for a family of 4 in 2006) because these women continued to be eligible for Medicaid benefits for more than 60 days after giving birth. In New Jersey, pregnant women with incomes up to 200% of the federal poverty line (or about $41,000 for a family of 4 in 2006) are eligible for Medicaid coverage during their pregnancy and for 60 days after delivery. However, after 60 days, their eligibility ends. Because this study required a year-long follow-up period, these women were excluded from this analysis. Consistent with other studies of depression, those with diagnoses of bipolar disorder or schizophrenia were excluded from the analysis due to comorbidities, complexity of diagnosis, and specific treatment requirements for severe mental illness.

**Variable Definitions**

Diabetes was defined in this study as having a diabetes diagnosis or filling a prescription for a diabetes medication either during the 6 months prior to or 1 year following delivery. A diabetes diagnosis was based on an International Classification of Diseases, Ninth Revision (ICD-9) code indicating either diabetes mellitus (codes starting with 250) or gestational diabetes (codes starting with 6480).

Diabetes medication use was indicated by national drug codes in patient prescription drug claims. These medications included those listed in the First DataBank (San Bruno, California) and categorized by the American Hospital Formulary Service (American Society of Health-System Pharmacists, Bethesda, Maryland) as α-glucosidase inhibitors, sulfonylureas, insulin, biguanides, meglintinides, thiazolidinediones, or other medications listed as antidiabetic agents. This list of medications was independently verified by 2 clinicians and 1 pharmacist as being representative of the scope of diabetes-specific medications. Women with and without diagnoses of gestational diabetes, and those who take and do not take insulin were flagged separately for additional analysis of diabetic subgroups. Those without gestational diabetes and not using insulin were assumed to have preexisting type 2 diabetes.

Depression was defined as either having a diagnosis or a prescription drug claim for an antidepressant medication. Depression diagnosis included depressive disorder, dysthymic disorder, or depressive adjustment disorder (ICD-9 codes 311, 296.2, 296.3, 300.4, 301.12, and 309.1). Antidepressant medications are identified by national drug codes found in the First DataBank and listed by the American Hospital Formulary Service as an antidepressant. Both medication use and diagnosis codes were used to identify depression, given that diagnosis codes have been shown to be underrecorded in Medicaid claims. Depression was coded as prenatal if it occurred before delivery and postpartum if it occurred on or after the day of delivery.

Other covariates included were age, race/ethnicity, delivery date, preterm birth, and cesarean delivery. Age was measured as the age at delivery. Race was self-reported by the woman at enrollment and categorized as black, white, or other, as recommended based on prior research using administrative claims. The delivery date was recorded as the date of the start of service on the Medicaid delivery claim. ICD-9 codes 644.20 and 644.21 indicated preterm birth (<37 weeks gestation) and diagnosis-related group codes 370, 371, 650, and 651 indicated cesarean delivery.

**Statistical Analysis**

With a total of 11,024 women, a diabetes prevalence of 6%, and at an α level of .05, this study has 80% power to detect an odds ratio (OR) of 1.53 and 90% power to detect an OR of 1.64 when comparing depression rates among those with diabetes with those without diabetes. All analyses use 2-tailed tests and α levels of .05. Descriptive statistics are presented as cross-tabulations of mean values and 95% confidence intervals (CIs). Two-tailed t tests were used to assess the difference in means.

Logistic regression was used to estimate the ORs of experiencing depression, measured as a dichotomous outcome, among women with and without...
diabetes. The ORs are from unadjusted models (crude ORs) and from models adjusted for possible confounders. Covariates included race/ethnicity, delivery date, preterm birth, and cesarean delivery. These covariates are included in the regression models because they are either known risk factors or because they were identified a priori and found to be associated with the exposure or the outcomes of interest. Because cesarean delivery may be associated with gestational diabetes, this variable was adjusted for separately in an additional model.

Preplanned stratified analyses were performed to assess associations separately for gestational and nongestational diabetes and for those who were and were not taking insulin. In addition, sensitivity analyses on various definitions of the outcome of interest were conducted to look at all indications of depression and at postpartum depression only, both including and excluding women with antenatal depression. All analyses were conducted using SAS statistical software version 9.1 (SAS Institute Inc, Cary, North Carolina).

The office of sponsored research at the Department of Ambulatory Care and Prevention (Harvard Medical School and Harvard Pilgrim Health Care) reviewed this study and waived institutional review board approval.

RESULTS

Data for 51,297 women who had Medicaid coverage at the time of their delivery were assessed from New Jersey’s Medicaid administrative claims database. Due to the structure of New Jersey’s Medicaid program, which offers limited coverage after pregnancy, 39,832 women were excluded because of the requirement for continuous eligibility in the year following delivery. Women excluded at this step did not differ from the retained cohort by age. However, the racial and ethnic composition of the continuously enrolled population changed from that of the original cohort. In particular, the Latina population decreased from 44% of the full data set to 8% of the retained cohort. This may be due to income fluctuations, mobility, seasonal employment, or other factors that may cause this population to disproportionately move in and out of Medicaid coverage. The 441 women excluded because of other severe mental illnesses were similar to those retained by race and ethnicity. The final study population included 11,024 women who met all study inclusion criteria.

Table 1 presents descriptive statistics for those women with and without diabetes with mean values and 95% CIs for each of the variables. Among this low-income population of new mothers, women with diabetes were older at the time of delivery than those without diabetes. While the proportion of black women was similar among those with and without diabetes, there was a higher proportion of white women among those without diabetes, and a higher proportion of those of other races (predominantly Latinas) among those with diabetes. There were no major differences in the timing of delivery between women with and without diabetes, but a New Jersey Medicaid coverage expansion in September 2005 caused an increase in the overall number of women in the study population in the latter half of the study period. On July 13, 2005, Governor Codey signed the Family Health Care Coverage Act, which reopened the New Jersey FamilyCare Medicaid program to new applicant parents or caretakers. Effective September 1, 2005, parents or caretakers

Table 1. Descriptive Statistics for Women With Diabetes Compared With Those Without Diabetes

<table>
<thead>
<tr>
<th></th>
<th>With Diabetes (n = 657)</th>
<th>Without Diabetes (n = 10,367)</th>
</tr>
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<tbody>
<tr>
<td>Age at delivery, y</td>
<td>28.4 (27.9-28.9)</td>
<td>25.0 (24.9-25.2)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>36.4 (32.7-40.1)</td>
<td>42.3 (41.4-43.3)</td>
</tr>
<tr>
<td>Black</td>
<td>46.0 (42.2-49.8)</td>
<td>45.3 (44.3-46.2)</td>
</tr>
<tr>
<td>Other</td>
<td>17.5 (14.6-20.4)</td>
<td>12.4 (11.8-13.0)</td>
</tr>
<tr>
<td>Period of delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July-December 2004</td>
<td>15.5 (12.8-18.3)</td>
<td>18.2 (17.4-18.9)</td>
</tr>
<tr>
<td>January-June 2005</td>
<td>6.2 (4.4-8.1)</td>
<td>6.8 (6.3-7.3)</td>
</tr>
<tr>
<td>July-December 2005</td>
<td>8.7 (6.5-10.8)</td>
<td>9.6 (9.0-10.2)</td>
</tr>
<tr>
<td>January-October 2006</td>
<td>69.1 (65.6-72.6)</td>
<td>65.0 (64.1-65.9)</td>
</tr>
<tr>
<td>High-risk pregnancy</td>
<td>72.8 (69.3-76.2)</td>
<td>30.6 (29.7-31.5)</td>
</tr>
<tr>
<td>Cesarean delivery</td>
<td>48.0 (44.1-51.8)</td>
<td>30.5 (29.6-31.3)</td>
</tr>
<tr>
<td>Preterm birth</td>
<td>11.1 (8.7-13.5)</td>
<td>9.1 (8.5-9.6)</td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prenatal</td>
<td>5.8 (4.0-7.6)</td>
<td>2.7 (2.4-3.0)</td>
</tr>
<tr>
<td>Postpartum</td>
<td>13.1 (10.5-15.7)</td>
<td>7.3 (6.8-7.6)</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.

*Unless otherwise indicated.
of dependent children younger than age 19 years whose income is equal to or less than 100% of the federal poverty line were eligible to apply for coverage (further expanded to 115% of the federal poverty line in September 2006 and 133% of the federal poverty line in September 2007).

As expected, rates of high-risk pregnancy and cesarean delivery were higher for women with diabetes. There was no significant difference in the rate of preterm birth between women with and without diabetes. Prenatal and postpartum depression were significantly more prevalent among women with diabetes than among those without diabetes in uncontrolled comparisons.

Both crude and adjusted ORs representing the association between different types of diabetes and perinatal depression are presented in Table 2. Women with any indication of diabetes were further classified as those with gestational diabetes who were not taking insulin, those taking insulin with no indication of gestational diabetes, those with both gestational diabetes and taking insulin medications, and those with indications of diabetes other than taking insulin medications or having gestational diabetes, which is assumed to be type 2 diabetes. In this sample of low-income women, those with any form of diabetes were nearly twice as likely to experience some indication of depression during pregnancy or postpartum, and this nearly 2-fold association did not significantly vary by diabetes classification. After controlling for the effects of age, race, year of delivery, and preterm birth, women with diabetes still had nearly double the odds of experiencing depression during the perinatal period (n=100, 15.2%) compared with those (n=886, 8.5%) who had no indication of diabetes (OR, 1.85; 95% CI, 1.45-2.36). Again, this association remained consistent across the various types of diabetes. When cesarean delivery was included in the regression models in addition to the other covariates, the results remained virtually unchanged.

The influence of diabetes and the odds of depression specifically during the postpartum period were examined (Table 3). In these analyses, 144 women with prenatal depression only (14 with diabetes and 130 without diabetes) were excluded. Among women with no indication of depression during the prenatal period, those with diabetes (n=62, 9.6%) had higher odds of experiencing new onset depression during the postpartum period (OR, 1.69; 95% CI, 1.27-2.23) compared with those without diabetes (n=604, 5.9%). When women who experienced both prenatal and postpartum depression are included, the association between diabetes and depression (n=86 [13.4%] vs n=756 [7.4%]) is strengthened (OR, 1.88; 95% CI, 1.47-2.41) due primarily to the strong correlation between prenatal and postpartum depression.

Table 2. Association Between Different Types of Diabetes and Odds of Depression During the Perinatal Period

Table 3. Association Between Diabetes and Odds of Postpartum Depression

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women in this population, those with diabetes have nearly twice the risk of having a depression diagnosis or taking an antidepressant medication during pregnancy or in the year following delivery. This result is consistent with systematic reviews and meta-analyses of the relationship between diabetes mellitus and major depressive disorder in a general adult population.14,20 These studies also find a doubling of the odds of depression among those with diabetes. Whether the woman took insulin medications or was diagnosed with gestational diabetes did not appear to alter the overall association between diabetes and depression in our study. Consistency of this association across diabetes subgroups also has been noted in prior research.20

To our knowledge, our study is the first to present data on the association between diabetes and depression during the perinatal period. Pregnancy and the postpartum period represent a time of increased vulnerability to depression.21 Treatable, perinatal depression is underdiagnosed, and it is important to target detection and support efforts toward women at high risk.30,31

Our study further indicates that diabetes status may be associated with an increased risk of new onset depression during the postpartum period in women who remain depression-free during the prenatal period. This finding is notable because women using state Medicaid services may be particularly vulnerable to postpartum depression due to higher rates of known risk factors, including stressful life events and limited emotional, social, or financial support.32,33 As such, state Medicaid programs may want to encourage health care providers to pay particular attention to managing the mental health concerns of women with diabetes during pregnancy and the postpartum period.

We recognize that this study is subject to a number of important limitations. With the available administrative data and study design, it was not possible to determine whether the association between diabetes and perinatal depression is causal. Administrative claims data contain limited variables for statistical adjustment. For example, we do not have data on personal or familial history of depression, weight or body mass index, or neonatal complications, and therefore cannot control for these factors in our analysis. We have noted, however, that in 2 earlier studies that assessed the association between diabetes and depression, the investigators adjusted for body mass index (the most important modifiable risk factor for type 2 diabetes) and found that it had little impact on the association between diabetes and depression.39,40

Another concern is that the quality of available data may suffer due to incomplete diagnostic codes, especially for depression.24,36 We made an attempt to lessen this bias by flagging medication use as an additional marker for diabetes and depression. The tradeoff is that our inclusive definition of depression (either receiving a diagnosis or antidepressant medication) may overestimate true diagnostically confirmed depression in the study population.37 However, a recent study that examined both pharmacy (medications) data and ICD-9 diagnostic codes from Medicaid programs in 4 states determined that models combining both diagnostic codes and pharmacy data (as we do in our depression measure) have superior overall performance in correctly classifying a wide range of chronic diseases (including depression) compared with models that used either approach alone.38

To address this in part, we ensured that those who were categorized as depressed based on antidepressant use did not also have another diagnosis (such as an anxiety disorder) for which antidepressants would be appropriately prescribed. Another measurement challenge relates to diabetes diagnoses. Prior research indicates that type 2 diabetes may be incorrectly characterized as gestational diabetes by diagnosing clinicians.13,20 However, given that our findings did not vary by diabetes classification, this bias would have had little impact on our estimated associations.

Finally, these results represent the association between diabetes and perinatal depression among women who were continually enrolled in New Jersey’s Medicaid program for the second and third trimesters of their pregnancy and a year following delivery. Findings from this specific population, while important, may have limited generalizability.

It is plausible that the observed association between diabetes and perinatal depression may indicate a potential causal association. Diabetes affects glycemic control and thyroid function, both of which impact the hypothalamic-pituitary-adrenal axis and cortisol levels.37 These hormonal changes may be important contributing factors in the development of depression during the perinatal period.39-41 In addition, psychosocial factors also may support a potential causal pathway through which diabetes may contribute to the development of perinatal depression. The stress of managing a chronic illness that poses risks to the woman and the infant may exacerbate depressive symptoms in pregnant women and new mothers.5,42 Furthermore, we cannot rule out the possibility that our association between diabetes and perinatal depression may be related to sleep disorders and obesity, which are both more commonly observed among women with type 2 diabetes.43,44 However, more research would be needed to assess the temporal relationships between these covariates.

Future research in this area may provide additional insights into the association between diabetes and perinatal depression. In particular, prospective cohort studies may help establish temporal sequencing, and clinical information could illuminate potential mechanisms of action and provide richer information regarding potential confounding by personal, socioeconomic, and medical factors. In addition, studies designed to test the impact of interventions that target those most vulnerable to depression during the perinatal period could provide helpful input to policy making. Among all women with depression, diabetes, or other mental or physical health conditions that complicate the normal course...
of pregnancy and postpartum recovery, careful monitoring and appropriate treatment are critical to ensuring the health of the mother and her child.

Author Contributions: Ms Kozhimannil and Dr Harlow had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Kozhimannil, Pereira, Harlow.

Acquisition of data: Kozhimannil

Analysis and interpretation of data: Kozhimannil, Pereira, Harlow.

Drafting of the manuscript: Kozhimannil, Pereira, Harlow.

Critical revision of the manuscript for important intellectual content: Pereira, Harlow.

Statistical analysis: Kozhimannil, Pereira.

Study supervision: Harlow.

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