Prenatal visit utilization and outcomes in pregnant women with type II and gestational diabetes

Ebony B. Carter, MD, MPH[1], **Methodius G. Tuuli, MD, MPH**[1], **Anthony O. Odibo, MD, MSCE**[2], **George A. Macones, MD, MSCE**[1], and **Alison G. Cahill, MD, MSCI**[1]

[1]Washington University School of Medicine, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine

[2]University of South Florida, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine

Abstract

Objective—To investigate the association between the number of prenatal visits (PNV) and pregnancy outcomes in women with gestational diabetes (GDM) and Type 2 diabetes (DM).

Study Design—A 4-year prospective cohort study of women with GDM and DM and was conducted. Patients ≥ 75th percentile for number of PNV were compared to those ≤ 25th percentile. The primary outcomes were large for gestational age (LGA) with birthweight > 90% and NICU admission for more than 24 hours. Secondary neonatal outcomes included severe LGA (>95%), shoulder dystocia, hyperbilirubinemia requiring phototherapy, neonatal hypoglycemia, low 5 minute APGAR score (<7) and preterm birth (prior to 37 weeks). Secondary maternal outcomes included mean 3rd trimester fasting blood glucose, hemoglobin A1c in labor, preeclampsia, gestational weight gain over Institute of Medicine recommendations, mode of delivery and maternal readmission within 30 days. Logistic regression was used to adjust for maternal race, nulliparity and BMI.

Results—Of 305 women, 4 were excluded for unknown number of PNV. Among the 301 included, the average number of visits was 12. Rates of LGA were similar between the high (28%) compared to low (18%) utilization groups (adjusted odds ratio [aOR] 1.69; 95% confidence interval [CI] 0.81–3.54). The high utilization group was 85% less likely to deliver an infant requiring NICU admission (aOR 0.15; 95% CI 0.04–0.53) and 59% less likely to have a preterm birth (aOR 0.41; 95% CI 0.21–0.80). A time-to-event analysis to account for the fact that patients who delivered earlier had fewer weeks to experience prenatal visits showed the risk for NICU admission was still significantly lower in the high prenatal visit utilization group (HR 0.15; 95% CI 0.04–0.51) after adjusting for confounders in a Cox proportional hazard model. The mean Hgb A1c at the time of delivery was significantly better in the high (6.4%) compared to low (6.9%)

CORRESPONDING AUTHOR: Ebony Boyce Carter, MD, MPH, Department of Obstetrics and Gynecology, Division of Maternal Fetal Medicine, 660 South Euclid Avenue, Maternity Building, 5th Floor, Campus Box 8064, St. Louis, MO 63110; P: (314) 747-1380 F: (314) 747-1429 cartere@wustl.edu.

utilization groups (p=0.01). There were no differences in other maternal outcomes based on prenatal care utilization.

Conclusion—Diabetic women with high PNV utilization have better glycemic control in the 3 months prior to delivery and are significantly less likely to deliver preterm infants or infants requiring NICU admission. There may be innovative ways to provide prenatal care for GDM and DM to optimize maternal and neonatal outcomes.

Keywords

diabetes; pregnancy outcomes; prenatal visit

INTRODUCTION

On the backdrop of the American obesity epidemic, the rates of pre-existing and gestational diabetes continue to increase and pose a significant threat to public health.[1] Women with this diagnosis are at increased risk for a host of adverse maternal and neonatal outcomes including hypertensive disorders of pregnancy, preterm birth, birth trauma, stillbirth and future cardiovascular disease; [2] yet, there is a paucity of information in the literature to guide the rational design of prenatal care to optimize maternal and neonatal outcomes. The current prenatal visit schedule recommended by the American Congress of Obstetrics and Gynecology (ACOG) includes a visit every 4 weeks until 28 weeks, every 2 weeks until 36, and weekly until delivery.[3] The recommendations go on to give the caveat that women with medical problems, such as diabetes, should be watched more carefully with the interval between visits dictated by the magnitude of the problem. However, it is unclear whether an intensive prenatal care schedule has any impact on maternal or neonatal outcomes for these high-risk women. The literature only suggests that women with gestational diabetes who are treated have improved perinatal outcomes compared to those who are not.[4–6]

We sought to estimate the associations between high and low quantity utilization of PNV and pregnancy outcomes in women with gestation diabetes (GDM) and type 2 diabetes (DM). Given that additional contact with an obstetric provider allows further opportunity for intensive education, support, and medication titration, we hypothesize that diabetic women with high prenatal care utilization will be more likely to have improved glycemic control, neonatal and maternal outcomes.

MATERIALS AND METHODS

This study was a retrospective secondary analysis of data from a prospectively collected cohort study of women with GDM and DM. The primary aim of the initial study was to determine whether fructosamine, glycated hemoglobin A1c or mean fasting glucose levels were associated with birth outcomes. The Institutional Review Board at Washington University School of Medicine in St. Louis approved the study. Women were recruited at the time of enrollment in prenatal care if they had DM, and at the time of diagnosis if they had GDM. Informed consent was obtained by a research nurse. Patients were excluded if they had type 1 diabetes mellitus by self-report and chart-review, carried a multiple gestation, or had known fetal anomalies. Subjects were cared for in the Center for Diabetes in Pregnancy

at Washington University School of Medicine/Barnes Jewish Hospital under the supervision of Maternal-Fetal medicine physicians.

Women were identified as having GDM through the two-step screening test recommended by ACOG [7] using a 50 g oral glucose load with a 1 hour blood sugar cut-off of 140 mg/dL and a 3 hour glucose tolerance test using the National Diabetes Data Group diagnostic criteria.[8] A1 GDM was defined as women with diet controlled disease while A2 GDM was anyone requiring medication for glycemic control.

A prenatal visit was defined as any scheduled visit with an obstetric provider (physician or nurse practitioner) in an outpatient setting during pregnancy and excluded appointments that were solely for antenatal testing or ultrasound. Our primary outcomes were large for gestational age (LGA) defined as birthweight > 90% by Alexander[9], and NICU admission for greater than 24 hours. Secondary neonatal outcomes included severe LGA (birthweight >95%[9]), small for gestational age (birthweight < 10%[9]), shoulder dystocia as documented by the physician in the labor and delivery record, hyperbilirubinemia requiring phototherapy, neonatal hypoglycemia (plasma glucose level of less than 30 mg/dL in the first 24 hours of life and less than 45 mg/dL thereafter), low 5 minute APGAR score (<7), umbilical artery blood gas pH< 7.10 (umbilical cord arterial gases are routinely sent following all deliveries at our institution) and preterm birth (delivery < 37 weeks gestational age). Gestational age was determined either by known last menstrual period consistent with ultrasound (within 7 days of a first-trimester ultrasound or 14 days of a second-trimester ultrasound) or by the earliest ultrasound if last menstrual period was unknown or inconsistent with ultrasound.[10]

Maternal secondary outcomes were mean 3rd trimester fasting blood glucose (by patient self-report through logs), Hemoglobin A1c (Hgb A1c) >7.0%, preeclampsia (systolic blood pressure 140 mmHg or diastolic blood pressure 90 mm Hg on two separate occasions at least 6 hours apart with proteinuria, defined as >1+ on urine dip or 300 mg in 24 hours), gestational weight gain (delivery weight minus pre-pregnancy weight) greater than Institute of Medicine (IOM) recommendations,[11] mode of delivery (vaginal, operative vaginal or cesarean) and maternal readmission within 30 days. All demographic and outcome data were extracted from the medical record by formally trained obstetrics research assistants and stored in the study database.

Upon initiation to care, patients received diabetes education and nutrition counseling. Treatment goals within the Center for Diabetes in Pregnancy include maintaining a fasting blood sugar < 95 mg/dL and 1-hour postprandial blood sugar < 140 mg/dL. Women with type 2 diabetes were generally managed with insulin while those with GDM received glyburide or insulin if > 50% of blood glucose measures at any point were above the aforementioned goals.

Baseline maternal characteristics were compared between women with GDM or DM who were in the top quartile of prenatal visits to those in the bottom quartile. Continuous variables were compared with descriptive and bivariate statistics using the unpaired Student t-test or Mann-Whitney U test for continuous variables and Chi-square or Fisher exact tests for categorical variables. The Kolmogorov-Smirnov test was used to test the normal

distribution of continuous variables. Multi-variable logistic regression models for outcomes of interest were developed to estimate the impact of a more intensive PNV schedule after adjusting for potential confounders. Relevant covariates for inclusion in the initial multivariable statistical models were selected based on biological plausibility and the results of the stratified analyses. Factors were removed in a backward stepwise fashion, based on significant changes in the adjusted odds ratio. The final model was adjusted for African American race, nulliparity and obesity, defined as body mass index (BMI) 30kg/m^2. Final models were tested with the Hosmer-Lemeshow goodness-of-fit test.

Since patients who delivered earlier had fewer weeks to utilize prenatal visits, we used time-to-event analysis to account for gestational age at delivery for both the primary outcomes and preterm birth. The Cox proportional hazard model was fitted to estimate hazard ratios (HRs), adjusting for potentially confounding factors, including African American race, nulliparity and obesity. The proportional hazards assumption was tested using Schoenfeld's global test. The statistical analysis was performed with STATA software (version 11, College Station, TX).

RESULTS

Of 305 women in the cohort, 4 were excluded because they had an unknown number of PNV. Among the 301 included, the average number of visits was 12 (range 1–25, interquartile range of 8–15 visits). Women in the top quartile of PNV (15 visits) were compared to those in the bottom quartile of PNV (8 visits).

The two study groups were similar with regard to maternal age, pre-pregnancy BMI, diabetes type (GDM or DM), Medicaid insurance, education and tobacco use (Table 1). Women in the lowest quartile of PNV utilization were more likely to be African American (74% vs. 60%; p=0.04). Women in the top quartile enrolled in the study earlier (mean 15.0 vs. 20.8 weeks; p<0.01), were more likely to be dated by a first trimester ultrasound (75% vs. 45%; P<0.01), and delivered slightly later (37.6 weeks vs. 36.4 weeks; p<0.01).

There was no difference in LGA infants in high (28%) compared to low (18%) prenatal care utilization (adjusted odds ratio [aOR] 1.69; 95% confidence interval [CI] 0.81–3.54). The high utilization group was 85% less likely to deliver an infant requiring NICU admission (aOR 0.15; 95% CI 0.04–0.53), 59% less likely to have a preterm birth (aOR 0.41; 95% CI 0.21–0.80) and 81% less likely to have an infant with a low Apgar score (aOR 0.19; 95% CI 0.04–0.91). There were no differences between the high vs. low utilization group for severe LGA>95%, shoulder dystocia, hyperbilirubinemia requiring phototherapy, neonatal hypoglycemia or SGA.

We used a time-to-event analysis to account for the effect of gestational age at delivery on NICU admission and preterm birth since patients who delivered earlier had fewer weeks to experience prenatal visits. After adjusting for confounders in a Cox proportional hazard model, the risk for NICU admission was still significantly lower in the high prenatal visit utilization group (HR 0.15; 95% CI 0.04–0.51) as was the risk for preterm birth (HR 0.47; 95% CI 0.27–0.83).

With regard to maternal outcomes, mean 3rd trimester blood glucose levels were similar between the two groups with a mean ± standard deviation of 90.2 mg/dL±14.8 vs. 94.6 mg/dL±30.2 (p=0.25), as seen in Table 2. The mean Hgb A1c at the time of delivery, a reflection of glycemic control over the prior 3 months, was significantly better in the high utilization group at 6.4% compared to 6.9% in the low utilization group (p=0.01); however, the risk of having an elevated Hgb A1c greater than 7% at the time of delivery was similar between groups after adjusting for African American race, nulliparity, and BMI (aOR 0.62; 95% CI 0.32–1.18). There were no significant differences with regard to the other maternal outcomes including preeclampsia, gestational weight gain in excess of IOM recommendations, interventions such as operative vaginal delivery or cesarean delivery or maternal readmission to the hospital.

DISCUSSION

We found that women with diabetes in pregnancy who were high utilizers of prenatal care had similar rates of LGA to low utilizers, but their infants were less likely to be premature and had lower rates of NICU admission.

Prior literature shows a reduced prenatal visit schedule in low-risk women is not detrimental to pregnancy outcomes in high income countries.[12–14] Our prior study of prenatal care utilization in a healthy population of pregnant women who delivered at term found there were generally no differences in high versus low prenatal visit utilization in low-risk women with regard to maternal or fetal outcomes.[13] However, high utilizers of care were more likely to undergo interventions including induction, operative delivery and Cesarean section—all of which are preferable to avoid in the absence of a compelling indication. The current study shows women with GDM and DM who are the highest utilizers of care also tend to have the best glycemic control in the 3 months prior to delivery with improved rates of preterm birth and NICU admissions. The traditional line of thinking that more prenatal care equals better prenatal care for everyone is challenged by the results of these studies and suggest that outcomes may be more nuanced in some populations, such as women with diabetes.

Our findings should be placed in the context of prior studies showing active management of diabetes in pregnancy improves outcomes.[4–6] The current study suggests one potential mechanism is through additional time with the obstetric provider. There is minimal time for patient education and engagement during the traditional 10–15 minute prenatal visit. Thus, women with diabetes in the top quartile of prenatal care utilization may optimize disease management through additional time with their provider for counseling, support and medication titration for glycemic control. There is evidence that improved glycemic control may reduce the risk of preterm birth,[15] which is consistent with our results.

Prenatal care was shaped to mitigate the complications of preeclampsia, and later to reduce the risk of low birth weight, preterm birth and the associated morbidity and mortality.[16] The Institute of Medicine's (IOM) 1994 report, *Preventing Low Birthweight*, estimated a $3.38 savings in caring for low birthweight infants for every dollar spent on prenatal care for high risk women. These findings helped to increase federal and state insurance funding for

prenatal care, but natural history studies of these programs have yielded mixed results with regard to improving pregnancy outcomes.[17–21]

Our study is the first, to our knowledge, to evaluate the association between high prenatal care utilization in women with GDM and type 2 diabetes and risk of adverse neonatal and maternal outcomes, but should be interpreted within the context of the following limitations. The number of prenatal visits in a pregnancy is impacted by the gestational age of the first prenatal visit, delivery timing, antenatal hospitalization, provider discretion in the context of pregnancy complications and patient compliance. Women in the high utilization group were less likely to deliver preterm; however, this may be due to reverse causality since women who delivered early-term had fewer weeks of pregnancy to attend PNV so they were more likely to be in the low utilization group. Women in the high utilization group in this study had, on average, 1 more week during their pregnancies (gestational age at delivery 37.6 vs. 36.4 weeks) to have a PNV. We attempted to address this with a time-to-event analysis which affirmed our results. The majority of women in both groups initiated care prior to the mid-2nd trimester based on time of enrollment and the trimester in which their dating ultrasound took place. We used the timing of their dating ultrasound as a proxy for when they initiated prenatal care since we did not have this information. Women in the high utilization group were enrolled in the study earlier (15 vs. 21 weeks), were more likely to be dated by a first trimester ultrasound (75% vs. 45%) and likely represent a different segment of our patient population. It is possible that providers intentionally and rationally scheduled patients for the additional visits that placed them in the high utilization group because they were having difficulty with glycemic control or had other pregnancy complications. If this was the case, we would expect our primary outcomes to be biased in the direction of worse neonatal outcomes in the high utilization group due to confounding by indication, which was not the case for NICU admission.

Our study findings must be taken in the context of the following limitations. We used number of prenatal visits as a proxy for prenatal care utilization, but this is likely an oversimplification since it accounts for neither the quality nor content of care. High utilizers had improved glycemic control in the 3 months prior to delivery, which did not translate into improved neonatal or maternal outcomes associated with hyperglycemia, such as LGA, shoulder dystocia, hyperbilirubinemia, neonatal hypoglycemia, mode of delivery and adherence to recommended weight gain goals. This may be due to a lack of power to evaluate these secondary outcomes. While we attempted to control for reverse causality with a time to event analysis, our results could still be biased because high utilizers tended to initiate care earlier and our analysis did not account for the distribution of visits throughout pregnancy. Finally, while we used appropriate statistical methods to control for confounders, it is possible there were additional confounders not accounted for in our model. We recognize that prenatal care is both an intervention and an indicator of maternal behavior. Thus, it is impossible to completely eliminate sources of bias in this regard.

While our study suggests an association between high prenatal care utilization in women with GDM/DM and decreased risk of adverse neonatal events like NICU admission, the cause-effect relationship remains unclear. Further research is needed to aid in the rational design of prenatal care to optimize glycemic control and pregnancy outcomes for these

patients in a randomized controlled trial that is powered to elucidate differences in glycemic control measures.

Our schedule for delivering prenatal care in the United States became the standard of care before any randomized controlled trials were conducted to prove efficacy and the provision of prenatal care for women with diabetes is largely left to provider discretion. There is little time for patient education and engagement during the course of traditional prenatal care and previous studies have unveiled a host of potential barriers to diabetes treatment including internal (stress, anxiety, loss of confidence), external (access, lack of sufficient information, cost, lack of social support), and factors linked to both social determinants and health care design and infrastructure.[22] Understanding which barriers are present in a given population, and subsequently tailoring care to optimize women's self-efficacy and meet their needs, is critical for obtaining satisfactory outcomes. Our results suggest that there may be a role for an enhanced PNV schedule for women with diabetes to improve glycemic control. Prospectively studying alternative, enhanced prenatal care models with an intensive educational component[23–26] focused on women with diabetes, are necessary to discover innovative means of caring for these high risk women to optimize maternal and neonatal outcomes.

Acknowledgments

REFERENCES

1. Albrecht SS, Kuklina EV, Bansil P, et al. Diabetes Trends Among Delivery Hospitalizations in the U.S., 1994–2004. Diabetes Care. 2010; 33(4):768–773. [PubMed: 20067968]

2. Practice Bulletin No. 137: Gestational diabetes mellitus. Obstet Gynecol. 2013; 122(2 Pt 1):406–416. [PubMed: 23969827]

3. Pediatrics AAo, Obstetricians ACo, Gynecologists. Guidelines for Perinatal Care: American Academy of Pediatrics. 2012

4. Landon MB, Spong CY, Thom E, et al. A multicenter, randomized trial of treatment for mild gestational diabetes. New England Journal of Medicine. 2009; 361(14):1339–1348. [PubMed: 19797280]

5. Crowther CA, Hiller JE, Moss JR, McPhee AJ, Jeffries WS, Robinson JS. Effect of treatment of gestational diabetes mellitus on pregnancy outcomes. New England Journal of Medicine. 2005; 352(24):2477–2486. [PubMed: 15951574]

6. Poolsup N, Suksomboon N, Amin M. Effect of treatment of gestational diabetes mellitus: A systematic review and meta-analysis. PLoS ONE. 2014; 9(3)

7. Practice Bulletin No. 137: Gestational Diabetes Mellitus. Obstetrics & Gynecology. 2013; 122(2, PART 1):406–416. [PubMed: 23969827]

8. Gavin JR, Alberti KGMM, Davidson MB, et al. Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care. 2003; 26(SUPPL. 1):S5–S20. [PubMed: 12502614]

9. Alexander GR, Himes JH, Kaufman RB, Mor J, Kogan M. A United States National reference for fetal growth. Obstetrics and Gynecology. 1996; 87(2 I):163–168. [PubMed: 8559516]

10. ACOG Practice Bulletin No. 101: Ultrasonography in Pregnancy. Obstetrics & Gynecology. 2009; 113(2, Part 1):451–461. [PubMed: 19155920]

11. Institute of M, National Research Council Committee to Reexamine IOMPWG. The National Academies Collection: Reports funded by National Institutes of Health. In: Rasmussen, KM., Yaktine, AL., editors. Weight Gain During Pregnancy: Reexamining the Guidelines. Washington (DC): National Academies Press (US) National Academy of Sciences; 2009.

12. McDuffie RS Jr, Beck A, Bischoff K, Cross J, Orleans M. Effect of frequency of prenatal care visits on perinatal outcome among low-risk women: A randomized controlled trial. Journal of the American Medical Association. 1996; 275(11):847–851. [PubMed: 8596222]

13. Carter EB, Tuuli MG, Caughey AB, Odibo AO, Macones GA, Cahill AG. Number of prenatal visits and pregnancy outcomes in low-risk women. Journal of perinatology. 2016; 36(3):178–181. Epub 2015 Dec 10. 2015. [PubMed: 26658123]

14. Dowswell T, Carroli G, Duley L, et al. Alternative versus standard packages of antenatal care for low-risk pregnancy. Cochrane database of systematic reviews (Online). 2010; (10)

15. Yogev Y, Langer O. Spontaneous preterm delivery and gestational diabetes: The impact of glycemic control. Archives of gynecology and obstetrics. 2007; 276(4):361–365. [PubMed: 17429669]

16. Alexander GR, Kotelchuck M. Assessing the role and effectiveness of prenatal care: History, challenges, and directions for future research. Public Health. 2002; 116(4):306–316.

17. Foster DC, Guzick DS, Pulliam RP. The impact of prenatal care on fetal and neonatal death rates for uninsured patients: A 'natural experiment' in West Virginia. Obstetrics and Gynecology. 1992; 79(1):40–45. [PubMed: 1727583]

18. Fisher ES, LoGerfo JP, Daling JR. Prenatal care and pregnancy outcomes during the recession: The Washington State experience. American Journal of Public Health. 1985; 75(8):866–869. [PubMed: 3895992]

19. Strobino DM, Chase GA, Kim YJ, Crawley BE, Salim JH, Baruffi G. The impact of the Mississippi improved Child Health Project on prenatal care and low birthweight. American Journal of Public Health. 1986; 76(3):274–278. [PubMed: 3946715]

20. Epstein AM, Newhouse JP. Impact of medicaid expansion on early prenatal care and health outcomes. Health Care Financing Review. 1998; 19(4):85–99. [PubMed: 25372068]

21. Peoles MD, Grimson RC, Lacy Daughtry G. Evaluation of the effects of the North Carolina improved pregnancy outcome project: Implications for state-level decision-making. American Journal of Public Health. 1984; 74(6):547–554.

22. Nielsen KK, Kapur A, Damm P, de Courten M, Bygbjerg IC. From screening to postpartum follow-up - the determinants and barriers for gestational diabetes mellitus (GDM) services, a systematic review. BMC Pregnancy Childbirth. 2014; 14(1):41. [PubMed: 24450389]

23. Housden L, Wong ST, Dawes M. Effectiveness of group medical visits for improving diabetes care: A systematic review and meta-analysis. CMAJ. 2013; 185(13):E635–E644. [PubMed: 23939218]

24. Ickovics JR, Kershaw TS, Westdahl C, et al. Group prenatal care and perinatal outcomes: A randomized controlled trial. Obstetrics and Gynecology. 2007; 110(2 I):330–339. [PubMed: 17666608]

25. Schellinger MM, Abernathy MP, Amerman B, et al. Improved Outcomes for Hispanic Women with Gestational Diabetes Using the Centering Pregnancy© Group Prenatal Care Model. Maternal and child health journal. 2016:1–9.

26. Mazzoni SE, Hill PK, Webster KW, Heinrichs GA, Hoffman MC. Group prenatal care for women with gestational diabetes. The journal of maternal-fetal & neonatal medicine. 2015:1–5.

Table 1

Baseline characteristics

	8 visits (n=83)	15 visits (n=96)	p-value
Maternal age (years)	29.50 (SD 5.99)	28.65 (SD 5.67)	0.33
Advanced Maternal Age	17 (20.48)	15 (15.63)	0.40
Race			
-African American	61 (73.49)	57 (59.38)	
-Caucasian	16 (19.28)	30 (31.25)	
-Latino/Hispanic	4 (4.82)	7 (7.29)	0.37
-Asian	1 (1.20)	1 (1.04)	
-Other	1 (1.20)	1 (1.04)	
African American race	61 (74.39)	57 (60.00)	**0.04**
Medicaid insurance	77 (92.77)	88 (91.67)	0.78
Education: less than high school diploma	24 (28.92)	22 (22.92)	0.36
Tobacco use	22 (26.51)	19 (20.00)	0.30
Prepregnancy BMI (kg/m^2)	34.35±12.68	33.90±11.57	0.81
Gravidity	3 (2–5)	2 (2–4)	**0.02**
Nulliparity	12 (14.46)	22 (22.92)	0.15
Type of Diabetes			
-A1GDM	4 (4.82)	4 (4.17)	
-A2GDM	16 (19.28)	20 (20.83)	0.10
-Type 2 DM	63 (75.90)	72 (75.00)	
Insulin during pregnancy	63 (75.90)	77 (80.21)	0.49
Prior cesarean	31 (37.35)	32 (33.33)	0.58
GA at study enrollment (wks)	20.78±8.57 20 (13–29)	15.09±8.85 11.5 (8–23)	**< 0.01**
Dating Ultrasound Time			
-1st Trimester	37 (45.12)	72 (75.00)	
-2nd Trimester	34 (41.46)	24 (25.00)	**<0.01**
-3rd Trimester	11 (13.41)	0	
Number of Prenatal Visits	6 (5–7)	17 (15–19)	**<0.01**
GA at Delivery (weeks)	36.37±2.99 37 (35–38)	37.55±1.77 38 (37–39)	**<0.01**

GA, gestational age; BMI, body mass index

Data are in the form of n (%), mean±standard deviation, or median (interquartile range).

Table 2

Measures of glycemic control and maternal and neonatal outcomes

	8 visits n=83	15 n=96	Unadjusted RR (95% CI)	Adjusted OR[*] (95% CI)
Primary Outcomes				
LGA (Birthweight>90%)	15 (18.07)	27 (28.13)	1.77 (0.87–3.62)	1.69 (0.81–3.54)
NICU admission	15 (18.07)	4 (4.17)	**0.23 (0.08–0.67)**	**0.15 (0.04–0.53)**
Fetal Secondary Outcomes				
Severe LGA (Birthweight>95%)	9 (10.84)	20 (20.83)	2.16 (0.93–5.06)	1.69 (0.81–3.54)
SGA (Birthweight<10%)	6 (7.23)	8 (8.33)	0.99 (0.37–2.61)	0.93 (0.32–2.76)
Shoulder dystocia	4 (4.82)	4 (4.21)	1.10 (0.28–4.23)	1.64 (0.37–7.21)
Hyperbilirubinemia requiring Phototherapy	28 (34.15)	26 (27.66)	0.74 (0.39–1.40)	0.74 (0.38–1.42)
Neonatal Hypoglycemia	5 (6.02)	4 (4.17)	0.70 (0.19–2.49)	0.74 (0.19–2.92)
5 minute APGAR<7	9 (10.84)	3 (3.13)	0.29 (0.08–1.03)	**0.19 (0.04–0.91)**
pH<7.10	11 (13.25)	12 (12.50)	1.01 (0.90–1.13)	1.31 (0.53–3.29)
PTB < 37 weeks	34 (40.96)	21 (21.88)	**0.53 (0.34–0.84)**	**0.41 (0.21–0.80)**
Maternal Secondary Outcomes				
Mean 3rd trimester fasting BG (mg/dL)	94.63 ± 30.21	90.2 ± 14.77	- -	- -
Mean Hgb A1c in labor[‡]	6.89±1.34	6.44±0.78	--	--
Hgb A1c > 7.0% at delivery	36 (43.37)	27 (28.13)	**0.65 (0.43–0.97)**	0.62 (0.32–1.18)
Preeclampsia	29 (34.94)	26 (27.08)	0.78 (0.50–1.20)	0.67 (0.35–1.29)
Gestational weight gain over IOM	42 (50.60)	60 (62.50)	1.24 (0.95–1.61)	1.44 (0.78–2.67)
Vaginal Delivery	34 (40.96)	38 (39.58)	0.97 (0.68–1.38)	1.13 (0.61–2.10)
Operative Vaginal Delivery	3 (8.82)	2 (5.26)	0.60 (0.11–3.36)	0.31 (0.03–2.97)
Cesarean	49 (59.04)	58 (60.42)	1.02 (0.80–1.30)	0.89 (0.48–1.65)
Maternal Readmission within 30 days	7 (8.43)	3 (3.13)	0.37 (0.10–1.39)	0.39 (0.09–1.57)

Data are in the form of n (%) or mean±standard deviation

[*] Adjusted for African American race, nulliparity, and obesity

[‡] Denotes $p<0.05$