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Prenatal counseling on type 2 diabetes risk, exercise, and nutrition affects the likelihood of postpartum diabetes screening after gestational diabetes

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Abstract

Objective—Screening rates for type 2 diabetes after a pregnancy with gestational diabetes are inadequate. We aimed to determine how prenatal counseling on exercise, nutrition, and type 2 diabetes risk affects postpartum screening for diabetes.

Methods—Using Pregnancy Risk Assessment Monitoring System data from Colorado (2009–2011) and Massachusetts (2012–2013), we performed multivariable logistic regression to examine the relationship between prenatal counseling and postpartum screening.

Results—Among 556 women, prenatal counseling was associated with increased postpartum diabetes screening, after adjusting for age, parity, and receipt of Women, Infants and Children (WIC) benefits (adjusted odds ratio (AOR) 3.0 [95%CI 1.4–6.5]). This effect was modified by race/ethnicity. Primiparity (AOR 2.2 [95%CI 1.2–4.1]) and advanced maternal age (AOR 2.2 [95%CI 1.2–3.8]) were associated with increased screening, and receiving WIC benefits was associated with decreased screening (AOR 0.5 [95%CI 0.3–0.9]).

Conclusions—In women with gestational diabetes, culturally appropriate counseling on future diabetes risk, nutrition, and exercise may enhance postpartum diabetes screening.

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Introduction

Gestational diabetes complicates ~ 5–9% of pregnancies in the United States.[1, 2, 3] The prevalence rises with age, BMI, non-white race, and lower socioeconomic status.[2] Further, gestational diabetes increases risk for infant macrosomia, neonatal hypoglycemia and hyperbilirubinemia, cesarean delivery, preeclampsia, and intrauterine fetal demise.[2, 3, 4] Maternal hyperglycemia is also associated with increased obesity and type 2 diabetes in offspring.[5, 6] Additionally, gestational diabetes increases a woman's lifetime risk for developing type 2 diabetes seven-fold, with greatest risk 5–10 years postpartum.[7]

Identification of high-risk women is essential because lifestyle change and metformin reduce type 2 diabetes risk by 50% at 3 years and 35%-40% at 10 years. Further, early treatment of type 2 diabetes lowers risk for complications.[8, 9] The American Diabetes Association, Endocrine Society, and American Congress of Obstetricians and Gynecologists recommend that women with gestational diabetes be screened 6–12 weeks postpartum for glucose abnormalities.[3, 10, 11, 12] The American Diabetes Association recommends diabetes screening every 1–3 years thereafter.[3]

Women with gestational diabetes should receive counseling on nutrition, exercise, weight gain, breastfeeding, risk for type 2 diabetes, and planning future pregnancies to reduce the risk of developing type 2 diabetes.[3, 10] Despite guidelines, half of women with gestational diabetes may not receive recommended postpartum screening for diabetes, and there is little information available on medically underserved communities.[13, 14, 15] Rates of postpartum diabetes screening are higher in older, primiparous women, with higher income and education, and Asian populations. Screening is lower among obese women with higher glucoses during pregnancy and large for gestational age infants.[14, 15, 16] These populations are at higher risk for developing diabetes. Further, prenatal counseling involves extensive information on multiple topics. Hence, the risk of developing type 2 diabetes after pregnancy and the importance of lifestyle modifications may not be fully recognized.[17]

The relationship between counseling during pregnancy complicated by gestational diabetes and postpartum diabetes screening has been explored in privately insured populations, specialty clinics, and single academic centers.[18, 19, 20] This study aims to determine how recall of counseling on type 2 diabetes risk, exercise, and nutrition during pregnancy associates with postpartum diabetes screening in a population sample, accounting for other important covariates. We hypothesize that those women who recall counseling during pregnancy will be more likely to report postpartum diabetes screening. This study addresses gaps in the literature by examining the relationship between prenatal counseling and postpartum follow-up in a population with racial, ethnic, socioeconomic and geographic diversity. Understanding how maternal recall of preventive counseling relates to postpartum screening will help inform future interventions.

Methods

Population, Main exposure and Outcome definition

Previously collected data were obtained from the Pregnancy Risk Assessment Monitoring System (PRAMS). PRAMS is a surveillance system established by the Centers for Disease Control and Prevention (CDC) to track rates of infant mortality and low birth weight.[21] As part of the PRAMS data collection process, birth certificate data were used to identify a stratified sample population of 100–250 women each month who had a live birth. States stratified the sample by low weight births and mother's race and ethnicity. Questionnaires were mailed to participants 2–4 months postpartum. Telephone surveys were conducted if there was no response after three mailing attempts. Core questions were asked in every state, and states selected from standard questions. Survey data were linked to birth certificate data. All data were weighted by the PRAMS protocol to adjust for the sampling design, nonresponse, and non-coverage, and states only reported data if the response rate was ≥ 60%. Sample weights were assigned to each respondent as the reciprocal of the sampling fraction assigned to that participant's stratum. Non-response adjustment weights were designed to compensate for segments of the population with lower response rates (e.g. lower education) and were the reciprocal of response rate for each category. Finally, non-coverage weights were assigned to account for records omitted in a particular time frame because of late processing. The analysis weight was determined by multiplying sampling, nonresponse and non-coverage weights and signifies the number of women in the population that each sample participant represents. Weights were provided in the data file received from the CDC, and the analysis weight was incorporated in all analyses using SAS complex survey software. In the results tables, the sample population frequency is reported with the weighted population frequency. The PRAMS team had informed consent for surveys, and our analysis was approved by the CDC and participating states in 2016. Detailed methodology from the PRAMS is outlined in previous studies.[22, 23] Data were de-identified, and the Washington University Human Research Protection Office reviewed the study in June 2016 and determined that the project did not require Institutional Review Board oversight.

The sample population was drawn from those who reported that during their *most recent* pregnancy, they were told by a doctor, nurse, or other health care worker that they had gestational diabetes (diabetes that started during *this* pregnancy). Colorado (2009–2011 phase 6) and Massachusetts (2012–2013 phase 7) asked both questions on prenatal counseling and postpartum screening. Prenatal counseling was assessed with the following question: 1) During *your most recent* pregnancy, when you were told that you had gestational diabetes, did a doctor, nurse, or other health care worker do any of the things listed below? a. refer you to a nutritionist, b. talk to you about the importance of exercise, c. talk to you about getting to and staying at a healthy weight after delivery, d. suggest that you breastfeed your new baby, e. talk to you about your risk for type 2 diabetes. Postpartum screening was assessed with the following question: 2) *Since your new baby was born*, have you been tested for diabetes or high blood sugar?

Covariate definition

Data from questions that were worded and coded differently in the two phases of the PRAMS were standardized and collapsed. Maternal age, race and ethnicity were obtained from birth certificates. Maternal age was stratified in 5-year blocks and dichotomized (≥ 35 for advanced maternal age). Maternal race and ethnicity variables were combined into a summary categorical variable: white non-Hispanic, black non-Hispanic, Asian/Pacific Islander, Hispanic and other. All individuals who answered that they were Chinese, Japanese, Filipino, Hawaiian, or other Asian and not Hispanic were coded as "Asian/Pacific Islander." Individuals who answered that they were Hispanic were coded as Hispanic, regardless of reported race. All others (American Indian, other or mixed race) were coded as "other" race/ethnicity. Reporting ≥16 years of education constituted finishing college. Medicaid coverage, WIC status, and primary language were taken from the questionnaire.

Maternal clinical characteristics included parity, whether the pregnancy was desired, prenatal care timing, and postpartum depression risk. Primiparity represented women reporting no previous live births before the current delivery. A "desired pregnancy" was coded for a woman who reported wanting to be pregnant (whether sooner, later, or at the time that she was pregnant). If she reported not wanting to be pregnant then or at any time in the future or was not sure what she wanted (phase 7 only), pregnancy was considered "not desired."

Prenatal care in the first trimester was defined as having a first prenatal care visit at ≤13 weeks gestation. High risk of post-partum depression was defined as feeling "down, depressed, or sad" (phase 6) or "down, depressed or hopeless" (phase 7) after childbirth "often" or "always." Answers of "sometimes," "rarely" or "never" on these questions were not considered high postpartum depression risk. Anyone reporting BMI ≥30 kg/m^2 was coded as obese.

Statistical Analysis

Code Availability—All analyses were completed between June and December 2016. We used SAS Enterprise Guide v. 7.1 (Cary, NC), with complex survey modules (procedures surveyfreq and surveylogistic) to account for weighted survey design. Code is available from the corresponding author upon request. We built a separate dataset to store the total number of primary sampling units (PSUs), and then brought these into the analyses using "total=." One variable (sud_nest) formed the strata in our stratified sample design, and a second variable (wtanal) represented the sampling weight. We used the NOMCAR option for Taylor series variance estimation to assume missing data were not missing completely at random.

We generated descriptive statistics on variables of interest. Bivariate analyses (using the Rao-Scott Chi Square test) assessed the relationship between each relevant counseling variable and the dichotomous outcome of postpartum diabetes screening. Bivariate analyses were also completed between each relevant covariate and our outcome of postpartum screening. Nutrition, exercise, and type 2 diabetes risk were independently significantly associated with the postpartum screening outcome. Therefore, we created a composite

counseling variable with three levels (0=received counseling on 0–1 topics, 1=received counseling on 2 topics, 2=received counseling on all 3 topics).

We constructed a multivariable logistic regression model to determine how this summary counseling variable was associated with postpartum diabetes screening. Our initial model contained only the counseling variable. We then sequentially adjusted for WIC status, age, parity, and race/ethnicity using a forward selection procedure. Each covariate was chosen because of significance in prior literature and $p<0.1$ in bivariate analyses. An interaction term was explored between race/ethnicity and counseling because race/ethnicity only became significant when counseling was in the model. The final model incorporated this interaction because it improved model fit significantly.

Results

In the PRAMS Colorado (2009–2011) and Massachusetts (2012–2013) surveys, 8,552 women responded (weighted population frequency of 326,245 individuals), and 603 reported a history of gestational diabetes in pregnancy (weighted population frequency of 19,994 individuals). This yielded an estimated gestational diabetes prevalence of 7.1% in this population, which is consistent with prior studies.[2, 24] Table 1 illustrates the characteristics of our study population.

The population was geographically, racially, ethnically, and socioeconomically diverse. Sixty three percent of the sample was from Colorado and thirty seven percent was from Massachusetts. More than half of the sample was from racial and ethnic minority groups. Fifty two percent of the population reported receiving WIC during pregnancy, indicating an income ≤185% of the Federal Poverty Level.[25]

The sample was older, with 23.5% qualifying as advanced maternal age. This was the first delivery for one third (33.4%) of the sample. Most of the sample reported that the pregnancy was desired and received prenatal care in the first trimester. Most of the population reported counseling on lifestyle during pregnancy (78.5% nutrition, 85.3% exercise, 76.0% weight gain, 79.4% type 2 diabetes risk, 75.3% breastfeeding). Sixty-four percent of the population reported counseling on exercise, nutrition and type 2 diabetes risk.

Bivariate comparisons of each potentially relevant covariate with postpartum diabetes screening are depicted in Table 2. Consistent with previous literature, advanced maternal age and primiparity were independently associated with increased postpartum diabetes screening (% of screened v. not screened: advanced maternal age 30.2% v. 16.8%, p=0.004; primiparity 39.7 v. 26.3% p=0.02). WIC status during pregnancy was associated with lower postpartum screening rates (% of screened v. not screened: 42.9% v. 59.9% p=0.003). Maternal race/ethnicity was not independently significantly associated with postpartum diabetes screening. However, it was included in the multivariable model as it has been a significant predictor in previous literature.[14, 15, 16, 26] Maternal education was significantly associated with screening; however, it was also significantly associated with WIC status during pregnancy and thus only WIC status was included in the final model.

A composite ordinal variable representing counseling on 0–1, 2, or 3 topics (exercise, nutrition, and type 2 diabetes risk) was our primary predictor of interest in the multivariable logistic regression model. Table 3 depicts the regression model. Data on one or more relevant predictors were missing in 47 individuals, hence the final model included 556 women (weighted population frequency of 18,234 individuals). A model that accounted for an interaction between counseling and race/ethnicity, and adjusted for advanced maternal age, parity, and WIC status, had the lowest −2 log likelihood. Without adjusting for the interaction, women who recalled being counseled on all three topics, as compared to zero or one topic, were three times more likely to be screened for diabetes postpartum (Adjusted OR (AOR) 3.0 [95% CI 1.4–6.5]). When an interaction between counseling and race/ethnicity was explored, the AOR for postpartum screening among those who received counseling on 3 v. 0–1 topics ranged from 1.2 [95% CI 0.4–3.7] among Hispanic women to 18.3 [95% CI 1.9–181.2] among black non-Hispanic women.

Both advanced maternal age (AOR 2.2 [95% CI 1.2–3.8]) and primiparity (AOR 2.2 [95% CI 1.2–4.1]) were associated with twice the likelihood of postpartum diabetes screening. Receiving WIC during pregnancy was associated with half the likelihood of postpartum screening (AOR 0.50 [95% CI 0.3–0.9]).

Discussion

To our knowledge, this study is the first and largest to demonstrate that recall of counseling on three lifestyle topics during pregnancy (type 2 diabetes risk, exercise, and nutrition) is significantly associated with increased postpartum diabetes screening in a diverse population. Moreover, race and ethnicity have not previously been demonstrated to modify the effect of prenatal counseling on postpartum screening. Postpartum diabetes screening rates in this population were consistent with previous studies, as fifty-one percent of the population reported screening for diabetes.[14, 16, 27] Pregnancy complicated by gestational diabetes represents a unique opportunity for intervention to reduce the incidence of type 2 diabetes. For adequate early detection and prevention of type 2 diabetes in this high-risk population, providers must collaborate across disciplines to recognize the risk and screen at recommended intervals.

Previous studies have focused on the importance of lifestyle modification and counseling as they are related to perinatal outcomes and behavior change during pregnancy. Randomized controlled trials have compared lifestyle counseling and standard prenatal care during pregnancy in obese women and those at risk for gestational diabetes. These studies have demonstrated a reduction in the incidence of gestational diabetes, increased exercise, improved diet, and less gestational weight gain in the intensive counseling group.[28, 29, 30, 31] Likewise, investigators have studied lifestyle interventions, similar to the Diabetes Prevention Program, after pregnancy among women with gestational diabetes. These interventions reduced postpartum weight retention, increased physical activity, and improved cardiovascular risk.[32, 33, 34, 35]

However, there are few studies that examine the relationship between counseling in pregnancy and screening for diabetes after pregnancy. One survey of 228 patients in a

private, managed care plan found that recall of diabetes screening advice during pregnancy was associated with twice the likelihood of postpartum screening. This was a predominantly white, college-educated population.[18] A retrospective study reported postpartum screening outcomes before (118 women) and after (147 women) implementation of a clinic with coordinated care and structured nutrition counseling. This study found that receiving care in the new clinic was associated with a three-fold greater likelihood of completing postpartum screening, adjusting for other confounders.[19] Finally, another study in a single academic center introduced a brief counseling session on postpartum diabetes risk with a certified diabetes educator at 37–38 weeks gestation. Postpartum screening rates increased two-fold in this cohort (245 in intervention group compared to 560 historical controls).[20]

Recall of counseling on all three topics compared to one or fewer topics was associated with a three-fold higher likelihood of postpartum diabetes screening as reported in the survey. This association persisted when adjusted for age, race/ethnicity, parity, and WIC status during pregnancy. Further, the effect of counseling on screening appeared to be modified by race/ethnicity. Odds ratios for postpartum screening among those who received counseling on 3 topics v. 0–1 topic varied widely by race/ethnicity. Hispanic women had the lowest odds of screening, followed by white non-Hispanic, Asian/Pacific Islander, and black non-Hispanic groups. Language was not included in the final model as it was not independently significant in bivariate comparisons. Significantly more Hispanic individuals noted that Spanish was their primary language. Counseling during pregnancy may have been less effective in this group if not delivered with sufficient translation services. Language does not explain the difference in the effect of counseling on screening among other racial and ethnic groups. Nonetheless, there are racial and ethnic disparities in both postpartum follow-up and risk of developing type 2 diabetes after gestational diabetes. Hence, our findings underscore the need for culturally appropriate interventions to ensure timely screening.[15, 26, 36]

In our analysis, advanced maternal age and primiparity were both associated with increased odds of postpartum screening, consistent with previous literature.[14, 15, 26] The finding that those on WIC were less likely to be screened was consistent with prior literature demonstrating that lower socioeconomic status is associated with lower rates of screening.[14, 15, 26] The WIC program provides education, supplemental foods, and medical referrals to young children and women who are pregnant, postpartum, and breastfeeding.[37] As women qualify up to one year after pregnancy and approximately 83% of all eligible infants participate in the program during their first year of life, the WIC program represents a possible setting for intervention to improve postpartum screening rates.[37] Interestingly, Medicaid status (during or outside of pregnancy) was not independently associated with postpartum diabetes screening, making it less likely that insurance status alone was driving associations between WIC status, counseling, and screening.

We acknowledge potential limitations of the study. First, as the PRAMS is a self-reported survey, recall bias is possible. Recall bias is minimized because the survey is completed between two and four months postpartum. It is possible that some women do not recall receiving counseling. If this is the case, the counseling received was ineffective and interventions must be improved. Likewise, it is possible that women do not recall being screened or recall screening that was done with a non-recommended test. However, the

reported screening rate in this study is similar to the screening rates from other studies, including those that had access to medical record data.[14, 15] Recall of counseling on lifestyle and diabetes risk during pregnancy may also be a proxy for access to health care and a provider who is more likely to recommend and complete screening after pregnancy. As PRAMS is a cross-sectional survey, we cannot conclude that there is a causal relationship between recall of counseling and higher screening rates. Moreover, for this study, we were limited to assessing variables collected in the PRAMS. We were not able to evaluate potentially important confounders including type and treatment of gestational diabetes, timing of gestational diabetes diagnosis, content and frequency of counseling, and credentials of the counselor. Finally, lack of data on other factors of acculturation limited our ability to assess the effect modification of race/ethnicity on counseling and postpartum screening. Language barriers likely play a role in the lower association between counseling and screening in the Hispanic population. We do not understand why counseling had a larger effect for black and Asian/Pacific Islander populations. Qualitative methods could explore components of effective interventions that vary by racial and ethnic group.

Despite these limitations, strengths of our study include population diversity and size as well as the number of different counseling topics assessed. Over fifty percent of the population reported racial and ethnic minority status and receipt of WIC services during pregnancy. Counseling on nutrition and exercise was assessed in addition to counseling on type 2 diabetes risk. The population was twice the size of populations in previous studies that had focused on insured, white, affluent, college-educated populations.[18, 19] PRAMS' weighted method of data collection, accounting for nonresponse and non-coverage, and oversampling traditionally underrepresented populations, confers additional strength to our study. PRAMS' standardized national data collection allows the use of data across multiple years and states, enhancing the diversity of the data and generalizability of the findings.

Conclusions

Our study highlights an association between prenatal counseling and postpartum diabetes screening. To establish a causal link between education on nutrition, exercise, and type 2 diabetes risk and postpartum screening, future study should investigate this association in a prospective, controlled trial. This prospective study could standardize counseling and account for potential confounders that the PRAMS was unable to address, such as type and treatment of gestational diabetes. Additionally, our study raises the possibility that the WIC program could be used to reach and improve screening rates in vulnerable populations. Administrative and clinical data may be leveraged to explore postpartum diabetes screening rates and factors associated with lack of screening among the medically underserved. Finally, as interventions to improve screening are designed, it will be important to develop and implement culturally appropriate counseling on type 2 diabetes risk, nutrition and exercise.

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Table 1

PRAMS sample and weighted population characteristics – CO (2009–2011) and MA (2012–2013)

	CO (2009–2011)			MA (2012–2013)		
Demographics	**Sample population frequency**	**Weighted population frequency**	**% of total sample**	**Sample population frequency**	**Weighted population frequency**	**% of total sample**
Age <20	11	*417*	2.1	2	*182*	0.9
Age 20–24	53	*2090*	10.5	17	*527*	2.6
Age 25–29	98	*3376*	16.9	58	*2057*	10.3
Age 30–34	116	*4195*	21.0	78	*2449*	12.2
Age 35+	98	*2576*	12.9	72	*2124*	10.6
Maternal race/ethnicity						
White non-Hispanic	191	*5218*	26.6	33	*3486*	17.8
Black non-Hispanic	7	*320*	1.6	45	*870*	4.5
Asian/Pacific Islander	16	*692*	3.5	84	*1325*	6.8
Hispanic	149	*6028*	30.8	44	*1335*	6.8
Other/mixed race	5	*80*	0.4	16	*234*	1.2
Medicaid during pregnancy	125	*4866*	24.5	104	*2955*	14.9
Medicaid outside of pregnancy	50	*2000*	10.0	85	*2408*	12.0
WIC during pregnancy	183	*7023*	35.2	115	*3304*	16.6
Non-English first language	88	*3865*	19.3	23	*761*	3.8
Education: mother finished college	88	*2750*	14.1	101	*3379*	17.3
Maternal Clinical Characteristics						
Primiparity	135	*3523*	18.0	87	*3006*	15.4
Desired pregnancy	336	*11073*	56.4	174	*5669*	28.9
Prenatal care in first trimester	342	*11120*	55.6	213	*6938*	34.7
High postpartum depression risk	57	*1968*	10.3	13	*526*	2.8
Obese	123	*3643*	18.2	65	*2157*	10.8
Counseling Variables						

	CO (2009–2011)			MA (2012–2013)		
Demographics	**Sample population frequency**	**Weighted population frequency**	**% of total sample**	**Sample population frequency**	**Weighted population frequency**	**% of total sample**
Exercise	314	*10699*	54.9	188	*5927*	30.4
Nutrition	291	*9375*	48.2	182	*5901*	30.3
Type 2 diabetes risk	281	*9467*	48.7	176	*5982*	30.7
Breastfeeding	272	*9760*	50.3	160	*4844*	25.0
Weight gain	267	*9231*	47.4	174	*5565*	28.6
Ordinal summary counseling variable						
Counseling on 0–1 topics [1]	57	*2162*	11.2	25	*858*	4.4
Counseling on 2 topics [1]	81	*2527*	13.0	50	*1449*	7.5
Counseling on 3 topics [1]	228	*7555*	39.0	142	*4828*	24.9

[1] Exercise, nutrition, and type 2 diabetes risk

Table 2

Bivariate comparisons of postpartum screening rates according to counseling status and other important covariates

	Sample population total (weighted population total)	Sample frequency in category n (%)	Screened frequency n (%)	Unscreened frequency n (%)	P value[2]
Demographics					
Advanced maternal age (35+)	597 (19683)	169 (23.6)	105 (30.2)	64 (16.8)	0.004
Maternal race/ethnicity	584 (19276)				0.06
White non-Hispanic		222 (44.6)	109 (46.5)	113 (42.5)	
Black non-Hispanic		50 (6.0)	33 (7.3)	17 (4.5)	
Asian/Pacific Islander		100 (10.5)	68 (13.3)	32 (7.5)	
Hispanic		191 (37.4)	93 (31.5)	98 (43.5)	
Other/mixed race		21 (1.6)	10 (1.3)	11 (1.9)	
Medicaid during pregnancy	593 (19566)	225 (38.7)	118 (35.8)	107 (41.8)	0.29
Medicaid outside of pregnancy	597 (19683)	134 (21.8)	70 (18.8)	64 (25.0)	0.17
WIC during pregnancy	596 (19653)	293 (51.2)	145 (42.9)	148 (59.9)	0.003
Non-English first language	597 (19683)	109 (22.7)	51 (19.1)	58 (26.5)	0.14
Education: mother finishedcollege	589 (19337)	189 (31.7)	118 (38.0)	71 (24.9)	0.02
Maternal clinical characteristics					
Primiparity	589 (19266)	219 (33.2)	133 (39.7)	86 (26.3)	0.02
Desired pregnancy	587 (19329)	505 (85.1)	273 (88.3)	232 (81.8)	0.11
Prenatal care in first trimester	597 (19683)	551 (90.8)	300 (93.6)	251 (87.9)	0.12
High postpartum depression risk	582 (18902)	69 (13.1)	31 (11.3)	38 (15.0)	0.39
Obese	597 (19683)	186 (28.9)	103 (28.3)	83 (29.5)	0.81
Counseling Variables					
Exercise	582 (19193)	497 (85.1)	284 (91.6)	213 (78.3)	0.001
Nutrition	583 (19167)	468 (78.2)	273 (83.8)	195 (72.3)	0.02
Type 2 diabetes risk	581 (19162)	454 (79.2)	271 (87.1)	183 (70.9)	<0.001
Breastfeeding	582 (19103)	427 (74.9)	250 (79.2)	177 (70.5)	0.10
Weight gain	583 (19190)	438 (75.9)	250 (77.4)	188 (74.2)	0.54
Ordinal summary counseling variable	578 (19087)				<0.001

	Sample population total (weighted population total)	Sample frequency in category n (%)	Screened frequency n (%)	Unscreened frequency n (%)	P value[2]
Counseling on 0–1 topics [1]		82 (15.8)	24 (8.3)	58 (23.8)	
Counseling on 2 topics [1]		129 (20.7)	61 (18.9)	68 (22.6)	
Counseling on 3 topics [1]		367 (63.5)	229 (72.8)	138 (53.6)	

[1] Exercise, nutrition, and type 2 diabetes risk

[2] P value from Rao-Scott Chi Square test comparing screened v. unscreened frequencies with $p<0.05$ considered statistically significant

Table 3

Multivariable adjusted association between counseling and postpartum diabetes screening
Primary outcome: Postpartum diabetes screening
Sample population frequency= 556
Weighted population frequency=18234

	Model 1 OR (95% CI)[1]	Model 2 AOR (95%CI) [2]	Final model AOR (95%CI)[3]	Final model (P value)[4]
Counseling on 3 v. 0–1 topics	3.5 (1.6–7.4)	3.0 (1.4–6.5)		
Counseling on 2 v. 0–1 topics	2.4 (1.0–5.6)	2.1 (0.9–5.3)		
Counseling on 3 v. 2 topics	1.5 (0.8–2.7)	1.4 (0.7–2.7)		
WIC during pregnancy		0.5 (0.3–0.9)	0.5 (0.3–0.9)	0.02
Advanced maternal age (35+)		2.1 (1.2–3.6)	2.2 (1.2–3.8)	0.007
Primiparity		2.1 (1.2–3.7)	2.2 (1.2–4.1)	0.008
White non-Hispanic		reference		
Black non-Hispanic		3.1 (1.2–8.3)		
Asian/Pacific Islander		1.6 (0.8–3.2)		
Hispanic		1.3 (0.7–2.6)		
Counseling on 3 v. 0–1 topics among white non-Hispanic women			4.6 (1.2–17.3)	0.02
Counseling on 3 v. 0–1 topics among black non-Hispanic women			18.3 (1.9–181.2)	0.01
Counseling on 3 v. 0–1 topics among Asian/Pacific Islander women			11.5 (2.1–62.9)	0.005
Counseling on 3 v. 2 topics among Asian/Pacific Islander women			10.2 (2.0–52.8)	0.006
Counseling on 3 v. 0–1 topics among Hispanic women			1.2 (0.4–3.7)	0.79
Model fit statistics				
AIC	24427	22982	22349	
- 2 Log Likelihood	24421	22962	22313	
Degrees of Freedom	2	9	17	
P value[5]	<0.001	<0.001	<0.001	

Abbreviations: AOR, Adjusted Odds Ratio; CI, Confidence Interval; OR, Odds Ratio

[1] Model 1 is unadjusted

[2] Model 2 is adjusted for WIC status, advanced maternal age, parity, race/ethnicity (this was created with sequential addition of the relevant covariates –intervening models not shown)

[3] Final model incorporates interaction term between counseling and race/ethnicity

[4] P value from multivariable logistic regression analysis of maximum likelihood estimates with statistical significance at p<0.05

[5] P value from likelihood ratio with second order Rao Scott design correction comparing larger model to smaller model with statistical significance at p<0.05