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Depression During Pregnancy and Adverse Birth Outcomes Among Predominantly Puerto Rican Women

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Abstract

Objectives—To examine associations between depression and preterm birth and small-for gestational age (SGA) among women of predominantly Puerto Rican descent, a population who experiences disparities in adverse birth outcomes and one of the highest infant mortality rates in the United States.

Methods—Proyecto Buena Salud (PBS) was a prospective cohort study conducted from 2006 to 2011 at a large tertiary care center in Western Massachusetts. Caribbean Islander (i.e., Puerto Rican and Dominican Republic) women were interviewed in early, mid and late pregnancy. Among 1262 participants, associations between depression, assessed using the Edinburgh Postnatal Depression Scale, and risk of preterm birth and small-for-gestational age (SGA) were evaluated.

Results—Women with at least probable minor depression [odds ratio (OR) = 1.77 (95% confidence interval (CI) = 1.02, 3.07)] or probable major depression [OR = 1.82 (95% CI = 1.01, 3.25)] in mid-pregnancy had an increased risk of SGA compared to non-depressed women in adjusted analyses. Borderline significant associations were observed between increasing levels of depressive symptom scores in early and mid-pregnancy [OR = 1.05 (95% CI = 1.00, 1.11) and OR = 1.04 (95% CI = 1.00, 1.09), respectively] and each additional trimester of exposure to probable major depression across mid- to late pregnancy [OR = 1.66 (95% CI = 1.00, 2.74)] and SGA. Late pregnancy depression was not associated with SGA; depression during pregnancy was not associated with preterm birth.

Conclusions for Practice—In this population of predominantly Puerto Rican women, mid-pregnancy depression increased risk for SGA. Findings can inform culturally appropriate, targeted interventions to identify and treat pregnant women with depression.

Keywords

Prenatal depression; Preterm birth; Small-for-gestational age; Birth outcomes; Latina perinatal health

Introduction

Preterm birth and low birthweight are among the leading causes of infant mortality and morbidity in the United States (Matthews and MacDorman 2013). Puerto Rican women experience disparities in these adverse birth outcomes and correspondingly, have one of the highest infant mortality rates in the U.S., despite comparable or only slightly higher rates among Latina women overall when compared to non-Latina White women (MacDorman 2011). This is critical as Puerto Ricans are the second largest subgroup among Latinas, who are the largest minority group in the country (Colby and Ortman 2014). Therefore, it is important to identify risk factors that can be addressed to prevent these adverse birth outcomes in this high-risk population.

Puerto Ricans tend to have poorer birth and general health outcomes compared to Latinos in the U.S. overall (MacDorman 2011; Zsembik and Fennell 2005). In 2011, the rate of preterm birth among Puerto Rican women was 14.5%, compared to 11.5% among non-Latina Whites (MacDorman 2011). Among Latinas, rates were highest among women of Caribbean descent from Puerto Rico or Cuba (13.4%), followed by women of Central or South American descent (12.1%); the lowest rates were observed among Mexicans (11.9%). Unlike other Latino subgroups, Puerto Ricans have U.S. citizenship and are considered migrants from the island when they move to the mainland. Unlike Mexican immigrants who tend to have better health compared to non-Latino Whites despite their lower socioeconomic status, Puerto Rican migrants have poorer health status (Zsembik and Fennell 2005). It has been suggested that migrant selectivity among Mexicans may explain this difference resulting in healthier Mexicans immigrating to the United States, whereas migrant selectivity is minimal among Puerto Ricans. This may also partly explain the finding that lower levels of acculturation are protective among Mexicans and several other Latino subgroups, but are associated with poorer health among Puerto Ricans (Zsembik and Fennell 2005). In addition, Puerto Ricans face other challenges including lower household incomes and higher rates of poverty than that of Latinos overall (Motel and Patten 2012). These differences likely contribute to the disproportionately higher rates of poor birth outcomes when compared to other Latina subgroups.

Prenatal depression is a potential risk factor for pre-term birth and intrauterine growth restriction, which is often defined as <10th percentile of the standardized birthweight distribution for gestational age, or small-for-gestational age (SGA). Puerto Rican women are at increased risk for depression during pregnancy with some studies finding estimates of probable depression during pregnancy as high as 53% among Latina populations (Zayas et al. 2003) and Puerto Ricans having the highest lifetime prevalence of depression among Latinas when disaggregating by Latina ethnic subgroups (Alegria et al. 2007).

Prior studies that have examined prenatal depression and adverse birth outcomes have been conflicting (Grote et al. 2010). In a meta-analysis conducted by Grote et al., of 20 studies examining this association, nine studies found that depression increased risk of PTB while the remainder found no effect (categorical depression pooled adjusted RR 1.24, 95% CI 1.02, 1.47) (Grote et al. 2010). Among 12 studies that examined the association between elevated depressive symptoms and SGA, two found a positive association with the remaining finding no effect (categorical depression pooled adjusted RR 1.17, 95% CI 0.82, 1.68) (Grote et al. 2010). No studies, to our knowledge, have focused on Puerto Rican women. In the only study we identified that was conducted among Latina women, Ruiz et al. prospectively examined associations between depressive symptoms, acculturation, estrone, progesterone and preterm birth among 470 Latina women of Mexican origin (Ruiz et al. 2012). In structural equation modeling, depressive symptoms were not independently significantly associated with preterm birth ($p > 0.05$), however the interaction between depressive symptoms and the ratio of progesterone and estriol collected at the same time point during pregnancy predicted risk (standardized coefficient = 0.18, $p < 0.05$).

Studies conducted among non-Latina White women and other populations have faced several limitations. The majority did not use depression measures validated for use in pregnant women and only collected information on depression at a single pregnancy time point limiting the ability to evaluate risk associated with the timing of exposure to depression (Szegda et al. 2014). Therefore, conflicting findings across studies may either be due to the differential effects of depressive symptoms over the course of pregnancy or to methodological differences between studies.

In addition, few studies have examined associations between duration of depression and adverse birth outcomes (Evans et al. 2007; Hoffman and Hatch 2000) with none focusing on risk of SGA or preterm birth. This is important to consider as fetal growth restriction may occur as a result of prolonged exposure to hormones associated with depression (e.g. cortisol, norepinephrine) (Field et al. 2006).

Therefore, we prospectively examined associations between depression at multiple pregnancy time points as well as duration of depression and risk of preterm birth and SGA in a population of Caribbean Islanders (i.e., Puerto Rican and Dominican Republic) who were predominantly Puerto Rican.

Methods

Study Design

Data from Proyecto Buena Salud (PBS) was used to examine associations between depression and adverse birth outcomes. PBS was a prospective cohort study conducted from 2006 to 2011 at Baystate Medical Center, a large tertiary care center in Western Massachusetts, which has approximately 4500 deliveries per year and serves an ethnically diverse population. Study design details have been published previously (Chasan-Taber et al. 2010). PBS was approved by the Institutional Review Boards at the University of Massachusetts, Amherst and Baystate Medical Center.

Briefly, women were recruited in early pregnancy at prenatal care visits (up to 20 weeks gestation), informed of study aims and procedures, and asked to provide written informed consent by trained bilingual interviewers. All interviews were conducted in English or Spanish, as preferred by the participant, to reduce language and literacy barriers.

At enrollment (mean = 12.4 weeks gestation), interviewers collected information on socio-demographic, acculturation, behavioral, and psychological factors. Information on behavioral and psychological factors were updated in mid-pregnancy (19–26 weeks gestation; mean = 21.3 weeks gestation) and late pregnancy (>26 weeks gestation; mean = 30.8 weeks gestation). Medical records were abstracted after delivery for information on medical history, clinical characteristics of the pregnancy, and birth outcomes. For some women, interviews were not able to be conducted for all pregnancy periods due to lack of time for interview prior to prenatal visit, inability to locate women at the clinic or over the telephone (e.g. phone disconnected), and preterm delivery.

Study Population

Eligibility for PBS was restricted to Caribbean Islanders (i.e., women of Puerto Rican or Dominican Republic ancestry), including, women: (1) born on these islands; or (2) who had at least one parent or two grandparents born on these islands. As PBS was initially conducted to assess the relationship between pregnancy factors and gestational diabetes, other exclusion criteria included: multiple gestation; history of diabetes, hypertension, heart or chronic renal disease; less than 16 or greater than 40 years of age; and current use of medications thought to adversely affect glucose tolerance.

A total of 1578 women were enrolled into PBS. For this analysis, women were not included if they had a miscarriage (n = 68) or an antepartum fetal death (n = 12), did not deliver at Baystate (n = 140), or were missing depression information for all three pregnancy periods (n = 96), leaving a final sample of 1262 participants.

Depression Assessment

The Edinburgh Postnatal Depression Scale (EPDS) (Cox et al. 1987) has been validated as a depression screening tool in pregnant and postpartum women (Gibson et al. 2009) and was used to assess depressive symptoms at each interview. The EPDS includes ten items in which respondents state how often they have experienced various moods in the past 7 days. Total scores range from 0 to 30 with 13 or greater categorized as at least probable minor depression and 15 or greater categorized as probable major depression (Matthey et al. 2006). Using these cut-points, the EPDS has been shown to have high sensitivity and specificity for major depression (sensitivity = 100%; specificity = 96%) and reasonable sensitivity and specificity for at least minor depression (sensitivity = 57%; specificity = 98%) in an English speaking population (Murray and Cox 1990). Studies validating the EPDS for postnatal depression in Spanish-speaking populations using the recommended cut-points for English-speaking populations have found good sensitivity and specificity for at least minor depression (sensitivity = 79%; specificity = 96%) and major depression (sensitivity = 83%; specificity = 97%) (Garcia-Esteve et al. 2003).

For each pregnancy period, women were categorized as to whether or not they had at least probable minor depression, as well as probable major depression. Depression data was available for each pregnancy period as follows: early pregnancy, n = 845 participants; mid-pregnancy, n = 781 participants; and late pregnancy, n = 764 participants. To be consistent with the prior literature (Dole et al. 2003), EPDS scores were imputed for participants missing fewer than 10% of EPDS scale items by replacing the missing value with the participant's average score of the nonmissing items. Depression was analyzed categorically (at least probable minor depression, probable major depression) and as a continuous depressive symptom score.

Duration of probable major depression was assessed from early-to-mid pregnancy for preterm birth and from early-to-late pregnancy for SGA. Duration of probable major depression was defined as the number of pregnancy periods with probable major depression during the pregnancy periods examined (i.e., 0, 1, 2 pregnancy periods).

Adverse Birth Outcomes

Preterm birth (<37 weeks gestation), gestational age at birth, and birthweight were abstracted from the medical record. Preterm birth was diagnosed by the hospital obstetricians based on their best clinical estimate of gestational age, which was typically determined by: (1) ultrasound if available, and (2) last menstrual period when ultrasound information was not available. The study obstetrician confirmed preterm birth status for all infants born at 37 weeks gestation or less. SGA was defined as a birthweight less than the 10th percentile for gestational age using gestational age-specific infant birthweight reference values from a population-based Latina sample (Alexander et al. 1999).

Covariates

Information on maternal age, education level, income, whether the participant was living with a partner, generation in the continental U.S., language preference for speaking, and psychological acculturation was obtained at the initial pregnancy interview. Language preference for speaking was used to determine the language in which the interview was conducted. Level of psychological acculturation was assessed with the Psychological Acculturation Scale, which is a ten-item scale that assesses an individual's sense of psychological attachment to and belonging within Anglo/American and Latino cultures (Tropp et al. 1999). Smoking status was assessed at each pregnancy interview, with pre-pregnancy status assessed at initial interview. Pre-pregnancy weight, height, parity, history of preterm delivery, and history of intrauterine growth restriction were obtained through the medical record. If pre-pregnancy weight was missing, self-reported weight from the initial interview was used. Pre-pregnancy height and weight were used to calculate body mass index (BMI). Trait anxiety was evaluated in early pregnancy and state anxiety in mid- and late pregnancy using the Spielberger State-Trait Anxiety Inventory (Spielberger 1983). Antidepressant prescriptions and self-reported antidepressant use was abstracted from the electronic prescription database and electronic medical records. Gestational weight gain during pregnancy was not included as a potential covariate as loss of appetite is a symptom of depression and a potential mechanism by which depression may lead to adverse birth outcomes.

Data Analysis

Unadjusted and multivariable logistic regression were used to model associations between the depression measures (i.e., depressive symptom score, at least probable minor depression, probable major depression) and each of the adverse birth outcomes. Early, mid- and late pregnancy depression measures were examined in models with SGA. Models examining associations with preterm birth included early and mid-pregnancy depression measures. Age, BMI and parity were included as a priori confounders in regression models as they are known risk factors for preterm birth and SGA (Goldenberg et al. 2008; McCowan and Horgan 2009); history of preterm birth was also included as an a priori confounder in preterm birth analyses. Other potential confounders were included in the final models if the odds ratio for the depression measure changed by more than 10% with their inclusion. Using this approach, acculturation, generation in the US, smoking, and anxiety met the criteria for inclusion. We also examined reduced models that did not include smoking and anxiety, as smoking may be in the causal pathway and anxiety may have construct and measurement overlap with depression (Bados et al. 2010). We also conducted an analysis stratifying by language of interview to assess whether associations varied depending on whether the interview was conducted in Spanish or English. As antidepressant use has been found to be associated with adverse birth outcomes in some studies (Udechuku et al. 2010), a sensitivity analysis was conducted excluding women who were identified as having been prescribed or reported taking antidepressants. Finally, we examined whether duration of probable major depression during pregnancy affected risk for adverse birth outcomes in unadjusted and adjusted analyses. All analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC).

Results

The mean age of study participants was 22.8 years (SD = 5.0) (Table 1). Almost half of participants were born in Puerto Rico or the Dominican Republic and 79.2% of the study population was categorized as having low levels of acculturation (Table 1). The majority of women preferred that their interview be conducted in English (75%). Women were generally of low socioeconomic status with only 6.3% of women reporting an income of greater than \$30,000. Almost half of participants had a pre-pregnancy BMI classified as overweight or obese and 41.7% of participants were nulliparous. Fourteen percent of women reported smoking in early pregnancy. Women who had lower levels of BMI, education, or parity, or who were smokers were significantly more likely to have an infant born SGA (Table 1). No associations were observed between level of acculturation or language of interview and either birth outcome. No associations were observed between any other baseline participant characteristics and preterm birth.

The overall mean EPDS score during pregnancy was 8.3 (SD = 5.5) (Table 2). In early pregnancy, 27.9% of participants were classified as having at least probable minor depression and 18.0% as probable major depression. Among study participants, 9.4% had a preterm birth (n = 119) and 12.7% an infant that was SGA (n = 158).

We evaluated the association between depression and risk of preterm birth. None of the depression measures (i.e., depressive symptoms, at least probable minor depression,

probable major depression) were associated with preterm birth in unadjusted or adjusted analyses (Table 3).

We then evaluated the association between depression and risk of SGA. Early pregnancy depressive symptoms score was not associated with SGA in unadjusted analyses [odds ratio (OR) = 1.02 (95% confidence interval (CI) = 0.98, 1.05)]. After adjusting for important risk factors, the association between early pregnancy depressive symptoms and SGA became more pronounced and were borderline significant, with each unit increase in depressive symptom score increasing risk for SGA by 5% [OR = 1.05 (95% CI = 1.00, 1.11)] (Table 3). This association was slightly attenuated in the reduced model that did not include adjustment for anxiety [OR = 1.02 (95% CI = 0.99, 1.06)]. At least probable minor depression and probable major depression in early pregnancy were not significantly associated with risk for SGA in adjusted analyses.

Mid-pregnancy depression measures were not significantly associated with SGA in unadjusted analyses (Table 4). However, in adjusted analysis a positive borderline significant association was observed with a unit increase in mid-pregnancy depressive symptom score increasing risk for SGA [OR = 1.04 (95% CI = 1.00, 1.09)]. In addition, at least probable minor depression and probable major depression were statistically significantly and positively associated with SGA in all adjusted models. Women with at least probable minor depression had a 77% higher risk of SGA compared to women who did not have probable depression [OR = 1.77 (95% CI = 1.02, 3.07)]. Similarly, risk was elevated among women with probable major depression [OR = 1.82 (95% CI = 1.01, 3.25)]. Associations between at least probable minor depression [OR = 1.66 (95% CI = 1.02, 2.70)] and probable major depression [OR = 1.72 (95% CI = 1.02, 2.90)] in mid-pregnancy and SGA were slightly attenuated, but still statistically significant, in reduced models that did not include adjustment for anxiety (results not shown). Finally, none of the depression measures assessed in late pregnancy were associated with SGA and preterm birth. No associations were observed in analyses stratified by the language of the interview.

As antidepressant use may confound the association between depression and adverse birth outcomes, a sensitivity analysis was conducted excluding the 31 women (2.4% of participants) identified as having likely used anti-depressants. Findings were unchanged compared to the main analysis.

We then evaluated the association between duration of probable major depression and preterm birth and SGA. Duration of probable major depression across early and mid-pregnancy was not associated with preterm birth. However, with increasing exposure to probable major depression across mid- and late pregnancy, the risk of SGA increased by 66% [OR = 1.66 (95% CI = 1.00, 2.74)] (Table 5), though findings were borderline significant.

Lastly, women missing depression information did not differ significantly from those with depression information by age, education, income, parity, acculturation level, generation living in the U.S., or whether they lived with a partner or spouse for any time period. However, those missing late pregnancy depression information were more likely to be

overweight or obese (48.7% vs. 43.7%; $p = 0.06$) and had more frequently smoked in early pregnancy (17.5% vs. 11.6%; $p = 0.01$).

Discussion

In this prospective cohort study of primarily Puerto Rican women, we found that those with at least probable minor depression or probable major depression in mid-pregnancy had a 70–80% increased risk of giving birth to an SGA infant compared to non-depressed women during this time period. We found no significant association for each additional trimester of exposure to probable major depression across mid- to late pregnancy and risk for SGA. There were also no significant associations between depression measures at any time point during pregnancy and preterm birth.

Women in our study experienced high rates of depression with 27.9% of women experiencing at least probable minor depression and 18.0% experiencing probable major depression in early pregnancy. There is substantial variation in rates of elevated depressive symptoms during pregnancy with women of low socioeconomic status or of color often experiencing higher rates (Rich-Edwards et al. 2006; O’Keane and Marsh 2007). Among Latina women, studies have reported a wide range of elevated depressive symptom rates from 16% (Rich-Edwards et al. 2006) to 53% (Zayas et al. 2003) that likely vary as a result of differences between the studies, including: depressive symptom screening instruments used, variation in cutpoints for categorization of elevated symptoms, timing of assessment during pregnancy, and the descent of Latinas included in the studies. For example, the few prior studies conducted that focused on Latina women primarily included Mexican American women and used depressive symptom assessment measures commonly used in population-based studies, such as the Center for Epidemiological Studies Depression Scale (CES-D) (Ruiz et al. 2012). However, as these scales were created for use in the general population, they include somatic symptoms of depression that are also common symptoms of pregnancy (e.g. fatigue) which could lead to an overestimate of elevated depressive symptom rates unlike the EPDS, which was specifically developed to account for these commonalities (Cox et al. 1987).

Our finding that depression increased the risk for SGA adds support to previous studies that found associations between early and mid-pregnancy depression and SGA. For example, in a prospective cohort study of 265 African-American women, Kim et al. found that elevated depressive symptoms assessed at the initial prenatal visit were positively associated with SGA in adjusted analysis (OR = 2.91, 95% CI = 1.26, 6.72), though smoking attenuated results somewhat (OR = 2.32, 95% CI = 0.96, 5.58) (Kim et al. 2013). While we did not find that each additional trimester of exposure to probable major depression across mid- to late pregnancy significantly increased risk for SGA, our elevated point estimate was consistent with prior studies. For example, among 10,967 women participating in the Avon Longitudinal Study of Parents and Children, Evans et al. found that women who scored higher than 12 on the EPDS at 18 and 32 weeks’ gestation had term infants with a birthweight 40.2 g lower (95% CI = 3.8–76.6, $p < 0.05$) than women who scored 12 or lower (Evans et al. 2007). However, upon adjustment, this association was attenuated and no longer significant.

In contrast, we did not find an association between depression during pregnancy and preterm birth. Prior studies have been conflicting (Grote et al. 2010; Szegda et al. 2014). In the meta-analysis by Grote et al., relative risks ranged from 1.01 to 4.90 among the 20 studies identified examining this association (Grote et al. 2010). Eleven of the studies found no significant association. Using the random-effects model, depression during pregnancy was significantly associated with preterm birth (RR 1.24; 95% CI 1.04–1.47), however significant heterogeneity was noted across studies ($Q_{19} = 49.0$; $p < 0.001$; $I^2 = 61\%$). In addition, none of the U.S.-based studies that observed a positive association ($n = 5$) utilized the EPDS.

Level of acculturation and language preference were not associated with preterm birth or SGA. Though some studies have found that lower levels of acculturation and Spanish language preference are protective for poor birth outcomes and health outcomes overall among some Latina subgroups, particularly Mexicans, studies have observed the converse for Puerto Rican women with lower acculturation associated with poorer health (Zsembik and Fennell 2005). When we stratified analyses according to language preference, we did not observe associations, though this is likely due to the small number of women who preferred speaking Spanish.

Mechanisms by which prenatal depression may lead to growth restriction are not clearly understood. Depression has been associated with HPA axis and sympathoadrenal dysregulation in some individuals and it is believed that elevated levels of hormones associated with these systems (i.e., cortisol, CRH, epinephrine) may restrict growth by altering the uterine environment (e.g. reduced uterine per-fusion) or directly affecting fetal growth processes (Field et al. 2006). In addition, unhealthy/risky health behaviors occurring as a symptom of depression (e.g. loss of appetite) may lead to growth restriction. As research suggests the possibility of differences in HPA axis function and the prevalence of health risk behaviors during pregnancy by race/ethnicity (Glynn et al. 2007; Chen et al. 2010; Siler Khodr et al. 2003; Field et al. 2002), it is important that further research considers these possible differences when examining potential mechanisms leading to disparities in adverse birth outcomes.

Our study had several limitations. While a score of 15 or higher on the EPDS is not a diagnosis of depression, the EPDS is commonly used to indicate probable depressive disorder in the antenatal and postpartum period and has been demonstrated to have good sensitivity and specificity when validated using a structured clinical interview to diagnose depression (Murray and Cox 1990). Though the EPDS does not diagnose depression, it allows for the systematic assessment of depression and reduces the misclassification that would occur if clinical records were utilized as depression during pregnancy is often underdiagnosed and under-treated (Marcus et al. 2003). Brief screening instruments are also useful in clinical practice because they allow for systematic screening of patient populations for high-risk individuals who may be in need of clinical intervention.

Rates of preterm birth were lower in the study population (9.4%) than national population estimates for Puerto Rican women (13.2%) in 2011 (Martin et al. 2013). In Springfield, Massachusetts, the city in which the medical center is located and where the vast majority

(85%) of Latinos are Puerto Rican, the rate of preterm birth among Latinas was 12.4% in 2010. This difference in rates may be due, in part, to the fact that women were recruited at prenatal care visits in early to mid- pregnancy and at-risk women are more likely to underutilize prenatal care (Partridge et al. 2012; Institute of Medicine Committee to Study Out-reach for Prenatal Care 1988).

Proyecto Buena Salud enrolled women of “Caribbean Island” descent, which included both Puerto Ricans and Dominicans to be consistent with the U.S. census (Chasan-Taber et al. 2010). While our study did not distinguish between these two Latina subgroups, U.S. census data indicates that 93.2% of citizens of Caribbean heritage in Springfield, Massachusetts are of Puerto Rican origin (U.S. Census Bureau 2009–2013).

Women missing information on depression did not differ significantly from those not missing this information in terms of sociodemographic and behavioral characteristics with the exception of BMI status and early pregnancy smoking. However, a potential limitation is the lack of information on history of depression prior to pregnancy, which is a strong risk factor for depression during pregnancy and may confound the association between prenatal depressive symptoms and birth outcomes. As depression relapse rates are particularly high during pregnancy (O’Keane and Marsh 2007), we anticipate that the impact on confounding would be minimal as it is likely that many women with a previous history of depression would also report depression during pregnancy.

Our study also has a number of strengths. Unlike previous studies that examined associations between depressive symptoms and adverse birth outcomes, it focuses on Latina women who are of Puerto Rican/Dominican descent. In addition, it has a relatively large sample size that includes both women who migrated/immigrated from these islands and women who were mainland U.S. born. Yet another strength is the use of the EPDS to screen for depressive symptoms, the only instrument that screens for elevated levels of depressive symptoms that takes into account the somatic symptoms of pregnancy.

Our study was the first, to our knowledge, to examine the cumulative duration of depression during pregnancy and risk of SGA. In addition, although some of the prior studies examining the association between depression and adverse birth outcomes adjusted for anxiety and other co-morbid psychological factors, the majority did not. More careful consideration of co-occurring psychological factors should be considered when examining these associations.

In summary, we found that mid-pregnancy depression increased risk for giving birth to an SGA infant in a prospective cohort study of predominantly Puerto Rican women. Culturally appropriate targeted interventions are needed to identify and treat women at high risk for depression during pregnancy to reduce disparities in adverse birth outcomes.

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Significance

Puerto Rican women experience disparities in adverse birth outcomes with disproportionately high rates compared to non-Latina Whites. Studies suggest depression may be a potential risk factor for adverse birth outcomes; however, they have faced several limitations. The majority did not use depression measures validated among pregnant women and only collected depression at a single pregnancy time point. In this prospective cohort study of predominantly Puerto Rican women, we found that depression in mid-pregnancy increased risk of giving birth to a small-for-gestational-age infant after adjusting for important risk factors. Findings can inform culturally appropriate, targeted interventions for pregnant women with depression.

Table 1
Participant characteristics by preterm birth and small for gestational age status: Proyecto Buena Salud, 2006–2011

	Total population (n = 1262)		Preterm birth cases (n = 119)		Small for gestational age cases (n = 158)	
	n ^a	%	n	%	n	%
						p value ^e
Maternal age (years)						
16–19	396	31.4	42	35.3	55	34.8
20–24	495	39.2	37	31.1	66	41.8
25–29	223	17.7	22	18.5	24	15.2
30	148	11.7	18	15.1	13	8.2
Education						
Less than high school	583	48.8	55	50.9	88	59.9
High school graduate or GED	388	32.5	38	35.2	37	25.2
Post high school	224	18.7	15	13.9	22	15.0
Income						
Less than \$15,000	357	30.2	27	25.0	45	30.8
\$15,000–\$30,000	182	15.4	16	14.8	20	13.7
\$30,000 or greater	75	6.3	6	5.6	5	3.4
Don't know/refused	570	48.1	59	54.6	76	52.1
Pre-pregnancy BMI (kg/m ²)						
less than 18.5	79	6.3	10	8.6	17	10.8
18.5 to <25.0	601	48.0	52	44.4	81	51.6
25.0 to <30.0	291	23.3	33	28.2	32	20.4
30 or greater	280	22.4	22	18.8	27	17.2
Parity						
0 live births	525	41.7	52	43.7	85	53.8
1 live birth	382	30.3	31	26.1	38	24.1
2 or more live births	352	28.0	36	30.3	35	22.2
Acculturation ^b						
Low	897	79.2	80	84.2	109	79.0
High	236	20.8	15	15.8	29	21.0

	Total population (n = 1262)			Preterm birth cases (n = 119)			Small for gestational age cases (n = 158)		
	n ^a	%	n	%	p value ^e	n	%	p value ^e	
Generation in U.S. ^c									
Born in PR/DR	573	46.9	60	52.6	0.41	69	44.8	0.80	
Parent born in PR/DR	578	47.3	49	43.0		77	50.0		
Grandparents born in PR/DR	70	5.7	5	4.4		8	5.2		
Language of interview									
English	897	75.1	80	70.2	0.30	111	73.0	0.55	
Spanish	292	24.5	34	29.8		41	27.0		
Other	5	0.4	0	0.0		0	0.0		
Live with partner/spouse									
No	575	48.7	48	44.9	0.41	72	49.3	0.89	
Yes	606	51.3	59	55.1		74	50.7		
Smoking (early pregnancy)									
No	722	86.0	72	81.8	0.24	74	76.3	<0.01	
Yes	118	14.1	16	18.2		23	23.7		
High trait anxiety ^d									
No	885	76.0	84	82.4	0.11	100	71.4	0.20	
Yes	280	24.0	18	17.7		40	28.6		

^aNumbers may not total to 1262 due to missing data^bPsychological Acculturation Scale Score: low = 1–2, high = 3–5^cBorn in PR/DR: participant born in Puerto Rico or Dominican Republic (PR/DR); parent born in PR/DR; grandparents born in PR/DR; born in U.S. but parents born in PR/DR; born in U.S., parents born in U.S., grandparents born in PR/DR^dSpielberger Trait Scale Anxiety Score: high (4th quartile) >47^ep value is for Chi square tests comparing cases and noncases

Distribution of depression among study participants by pregnancy time period; Proyecto Buena Salud, 2006–2011

Table 2

	Early pregnancy (n = 845)		Mid pregnancy (n = 781)		Late pregnancy (n = 764)	
Depressive symptom score (mean, SD)	9.1	5.9	8.4	6.1	7.4	5.8
At least probable minor depression (n, %) ^a	236	27.9	194	24.8	149	19.5
Probable major depression (n, %) ^b	152	18.0	145	18.6	99	13.0

^aEPDS Score 13 indicates at least probable minor depression

^bEPDS Score 15 indicates probable major depression

Table 3

Unadjusted and multivariable odds ratios and 95% Confidence intervals for depression and preterm birth by pregnancy time period: Proyecto Buena Salud, 2006–2011 *OR* odds ratio, *CI* confidence interval

Preterm birth					
Cases		Unadjusted model		Adjusted model ^d	
N	%	OR	95% CI	OR	95% CI
Early pregnancy					
Depressive symptom score ^a					
		0.98	0.94, 1.02	1.02	0.95, 1.09
At least probable minor depression ^b					
No	68 11.2	1.00	Referent	1.00	Referent
Yes	20 8.5	0.74	0.44, 1.24	0.99	0.47, 2.08
Probable major depression ^c					
No	77 11.1	1.00	Referent	1.00	Referent
Yes	11 7.2	0.64	0.32, 1.21	0.83	0.33, 2.08
Mid pregnancy					
Depressive symptom score ^a					
		1.00	0.96, 1.04	1.00	0.94, 1.05
At least probable minor depression ^b					
No	53 9.0	1.00	Referent	1.00	Referent
Yes	17 8.8	0.97	0.55, 1.72	0.91	0.45, 1.85
Probable major depression ^c					
No	59 9.3	1.00	Referent	1.00	Referent
Yes	11 7.6	0.80	0.41, 1.57	0.79	0.36, 1.73

^aContinuous depressive symptom score

^bEPDS Score 13 indicates at least probable minor depression

^cEPDS Score 15 indicates probable major depression

^dEarly pregnancy: Adjusted for maternal age, pre-pregnancy BMI, parity, history of PTB, acculturation, trait anxiety. Mid-pregnancy: maternal age, pre-pregnancy BMI, parity, history of PTB, generation in U.S., mid-pregnancy smoking, mid-pregnancy state anxiety

Table 4

Unadjusted and multivariable odds ratios and 95% confidence intervals for depression and small-for-gestational age by pregnancy time period; Proyecto Buena Salud, 2006–2011 OR odds ratio, CI confidence interval

	Small for gesta-tional age		Unadjusted model		Adjusted model ^d	
	n	%	OR	95% CI	OR	95% CI
Early pregnancy						
Depressive symptom score ^a			1.02	0.98, 1.05	1.05	1.00, 1.11
At least probable minor depression ^b						
No	66	11.0	1.00	Referent	1.00	Referent
Yes	32	13.7	1.30	0.82, 2.04	1.71	0.90, 3.22
Probable major depression ^c						
No	75	10.9	1.00	Referent	1.00	Referent
Yes	23	15.3	1.48	0.89, 2.44	1.78	0.90, 3.52
Mid pregnancy						
Depressive symptom score ^a			1.03	0.99, 1.06	1.04	1.00, 1.09
At least probable minor depression ^b						
No	64	11.0	1.00	Referent	1.00	Referent
Yes	29	15.0	1.43	0.89, 2.29	1.77	1.02, 3.07
Probable major depression ^c						
No	70	11.1	1.00	Referent	1.00	Referent
Yes	23	16.0	1.52	0.91, 2.53	1.82	1.01, 3.25
Late pregnancy						
Depressive symptom score ^a			1.03	0.99, 1.06	1.01	0.96, 1.06
At least probable minor depression ^b						
No	71	11.7	1.00	Referent	1.00	Referent
Yes	22	14.9	1.32	0.79, 2.22	0.92	0.47, 1.82
Probable major depression ^c						
No	77	11.7	1.00	Referent	1.00	Referent

	Small for gesta-tional age		Unadjusted model		Adjusted model ^d	
	n	%	OR	95% CI	OR	95% CI
Yes	16	16.3	1.48	0.82, 2.65	0.99	0.47, 2.09

^aContinuous depressive symptom score

^bEPDS Score 13 indicates at least probable minor depression

^cEPDS Score 15 indicates probable major depression

^dEarly pregnancy: adjusted for maternal age, pre-pregnancy BMI, parity, trait anxiety. Mid pregnancy: adjusted for age, pre-pregnancy BMI, parity, mid-pregnancy state anxiety. Late Pregnancy: maternal age, pre-pregnancy BMI, parity, pre-pregnancy smoking, late pregnancy state anxiety

Unadjusted and multivariable odds ratios and 95% confidence intervals for duration of probable major depression and small-for-gestational age across pregnancy time periods; Proyecto Buena Salud, 2006–2011 *OR* odds ratio, *CI* confidence interval

Table 5

Small for gestational age		Unadjusted model		Adjusted model ^b	
	n %	OR	95% CI	OR	95% CI
Early to mid-pregnancy					
Continuous variable					
Number of trimesters with probable major depression (0,1,2) ^a	51 10.7	1.23	0.80, 1.88	1.30	0.84, 2.03
Categorical variable					
0 trimesters	34 9.8	1.00	Referent	1.00	Referent
1 trimester	12 13.6	1.45	0.72, 2.94	1.51	0.73, 3.10
2 trimesters	5 12.5	1.32	0.48, 3.58	1.52	0.54, 4.23
Mid to late-pregnancy					
Continuous variable					
Number of trimesters with probable major depression (0,1,2)	44 11.5	1.48	0.92, 2.38	1.66	1.00, 2.74
Categorical variable					
0 trimesters	30 10.2	1.00	Referent	1.00	Referent
1 trimester	9 13.6	1.38	0.62, 3.08	1.59	0.68, 3.73
2 trimesters	5 20.8	2.31	0.80, 6.63	2.82	0.92, 8.61

^a EPDS Score 15 indicates probable major depression

^b Adjusted for maternal age, pre-pregnancy BMI, and parity