Prenatal Perceived Stress and Adverse Birth Outcomes Among Puerto Rican Women

Kathleen Szegda, PhD,¹⁻³ Elizabeth R. Bertone-Johnson, ScD,¹ Penelope Pekow, PhD,¹ Sally Powers, EdD,⁴ Glenn Markenson, MD,⁵ Nancy Dole, PhD,⁶ and Lisa Chasan-Taber, ScD¹

Abstract

Background: Preterm birth and low birthweight contribute substantially to the disproportionately high infant mortality rates experienced by Puerto Ricans in the United States. The purpose of this study was to examine whether the timing and pattern of prenatal psychosocial stress increased risk of adverse birth outcomes in this high-risk population.

Materials and Methods: Proyecto Buena Salud was a prospective cohort study conducted from 2006 to 2011 among predominantly Puerto Rican women. Participants ($n=1,267$) were interviewed in early, mid-, and late pregnancy. We evaluated associations between early and mid-pregnancy stress (Perceived Stress Scale) and preterm birth and low birthweight, and stress at each pregnancy time point and small for gestational age (SGA).

Results: Elevated levels of perceived stress in mid-pregnancy increased risk for preterm birth and low birthweight in adjusted analyses, with a linear trend observed for each increasing quartile of stress ($p_{\text{trend}}=0.01$). Women in the highest quartile of stress experienced three times the risk for preterm birth (odds ratio [OR]=3.50, confidence interval [95% CI]: 1.38–8.87) and low birthweight (OR=3.53, 95% CI=1.27–9.86) compared with women in the lowest quartile. Early pregnancy stress was not associated with preterm birth or low birthweight. Increase in stress from early to late pregnancy increased risk for SGA (OR=1.90, 95% CI=1.01–3.59); no associations were found between stress at any timepoint and SGA.

Conclusion: Elevated levels of mid-pregnancy perceived stress increased risk for preterm birth and low birthweight, and an increase in stress over the course of pregnancy increased risk for SGA in a population of predominantly Puerto Rican women.

Keywords: stress, preterm birth, low birthweight, small for gestational age, prematurity, growth restriction, Latina health

Introduction

PUERTO RICAN WOMEN experience disparities in infant mortality with rates that are 37% higher than those of non-Latina White women, despite comparable rates between non-Latina Whites and Latinas overall.¹ The high incidence of preterm birth and low birthweight among Puerto Rican women contributes to this disparity, with disorders related to these adverse birth outcomes identified as the leading cause of infant mortality among these women.² Consequently, it is

important to identify risk factors that can be addressed to prevent premature birth and growth restriction during pregnancy in this high-risk population.

Prenatal psychosocial stress has been identified as a potential risk factor for preterm birth, low birthweight, and small for gestational age (SGA).³ Hypothalamic-pituitary-adrenal (HPA) axis hormones (*e.g.*, corticotrophin-releasing hormone [CRH], cortisol) and catecholamines released as part of the stress response are hypothesized to lead to early parturition and growth restriction.⁴ Prenatal stress may also

¹Department of Biostatistics and Epidemiology, School of Public Health and Health Sciences, University of Massachusetts, Amherst, Massachusetts.

²Baystate Health System, Springfield, Massachusetts.

³Partners for a Healthier Community, Springfield, Massachusetts.

⁴Department of Psychological and Brain Sciences, University of Massachusetts, Amherst, Massachusetts.

⁵Baystate Medical Center, Springfield, Massachusetts.

⁶Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina.

lead to risky health behaviors that increase risk for adverse birth outcomes (*e.g.*, smoking, inadequate nutrition).

Puerto Ricans experience numerous socioeconomic stressors, including high poverty rates that are greater than non-Latina Whites and Latinos as a whole.⁵ As the impact of socioeconomic stressors on health has been found to vary among Latinos based on descent, with Puerto Ricans impacted to a greater degree than Mexicans and some other Latino populations, it is important to understand the role of stress in contributing to disparities in birth outcomes in this high-risk population.⁶ Differences in migrant selectivity between Puerto Ricans and other Latino populations have been hypothesized to explain these differences, emphasizing the need to examine associations among Puerto Ricans.⁶

Studies examining associations between psychosocial stress and adverse birth outcomes have been conflicting, finding either no association or increased risk due to stress.^{7–12} Variation in the timing of assessment of stress during pregnancy likely accounts for some differences in study findings. Research suggests that impacts of exposure to stressors and elevated levels of stress hormones on the developing fetus vary depending on the pregnancy period of exposure.³ However, the majority of studies only examined psychosocial stress at a single time point during pregnancy or did not clarify the timing of assessment, making it difficult to distinguish varying effects across pregnancy.^{8,9,11,13,14}

In addition, use of a single pregnancy stress assessment is insufficient to evaluate the potentially complex associations between the pattern of stress exposure and the risk of adverse birth outcomes. Because research suggests that both the physiologic stress response and the assessment of experiences as stressful typically decrease over the course of pregnancy, an increase in perceived stress during the course of pregnancy may indicate increased risk.^{15,16} For example, Glynn et al. found that a single time point assessment of stress in the second and third trimester was not associated with risk of preterm birth, whereas an increase in perceived stress from the second to third trimester was associated with elevated risk.¹⁵

The few studies that examined patterns of stress over pregnancy found that an increase in stress during pregnancy was associated with decreased gestational age at birth,^{15,17} but none to our knowledge focused on low birthweight or SGA. Unlike low birthweight, SGA, defined as a birthweight less than the 10th percentile for gestational age, is a measure of potential growth restriction that takes into account gestational age at birth. Identifying both critical exposure periods during pregnancy when elevated psychosocial stress levels may increase risk for adverse birth outcomes as well as patterns of stress that increase risk will enable providers to more effectively target the screening of patients to identify and intervene among those at high risk.

Studies also suggest that effects of psychosocial stress on birth outcomes may vary from that of depression and anxiety as a result of different mechanisms of action associated with each of these psychological factors.¹⁸ Many prior studies did not adjust for these other psychological factors, and, thus, it is not clear whether the associations observed were a result of elevated perceived stress levels or these other psychological factors.^{9,10,19–22} Finally, few studies have focused on perceived stress and birth outcomes among Latina women,²³ with none that we are aware of focused on Puerto Rican women, a population at high risk for both elevated psychosocial stress and adverse birth outcomes.

Therefore, we prospectively examined associations between perceived stress in early, mid-, and late pregnancy and preterm birth, low birthweight, and SGA in a population of predominantly Puerto Rican, Latina women who have been exposed to numerous chronic socioeconomic stressors. In addition, we examined whether change in stress over the course of pregnancy was associated with these adverse birth outcomes.

Materials and Methods

Study design

Data from Proyecto Buena Salud (PBS) were used to assess associations between perceived stress 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 Springfield, Massachusetts, which has ~4,500 deliveries per year and serves an ethnically diverse population. Study design details have been previously published.²⁴ PBS was approved by the Institutional Review Boards at the University of Massachusetts, Amherst, and Baystate Medical Center.

Women were recruited at prenatal care visits in early pregnancy (up to 20 weeks of gestation) by trained bilingual interviewers. Participants were informed of study aims and procedures and asked to provide written informed consent. To reduce language and literacy barriers, interviews were conducted in English or Spanish depending on participant preference.

Women were interviewed in early (mean = 12.4 weeks of gestation), mid- (19–26 weeks of gestation; mean = 21.3 weeks of gestation), and late pregnancy (>26 weeks of gestation; mean = 30.8 weeks of gestation). At the initial interview, information was obtained on socio-demographic, acculturation, behavioral, and psychological factors, including perceived stress. Information on behavioral and psychological factors was updated in mid- and late pregnancy. After delivery, medical records were abstracted for information on medical history, clinical characteristics of the pregnancy, and birth outcomes.

Study population

Eligibility for the PBS study was restricted to women of Puerto Rican or Dominican Republic descent who were born on one of these islands, or had at least one parent or two grandparents born on these islands. 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 believed to adversely affect glucose tolerance.

A total of 1,579 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 stress information for all three pregnancy periods ($n = 92$). The final sample consisted of 1,267 participants who had information on perceived stress for one or more pregnancy periods.

Assessment of perceived stress

Perceived stress was assessed at each interview by using Cohen's 14-item Perceived Stress Scale (PSS).²⁵ The PSS assesses levels of global perceived stress and is theorized to inherently account for components of the appraisal process, including assessment of potential psychosocial stressors as

demanding and the availability of coping resources (e.g., social support). Total scores range from 0 to 56, with higher scores indicating higher levels of stress.

Among the 1,267 PBS participants who had information on perceived stress, a total of 862 had information on stress in early pregnancy, 794 in mid-pregnancy, and 766 in late pregnancy. For some women, interviews could not be conducted for all pregnancy periods as a result of the following: lack of time for the interview before the prenatal visit, inability to locate women at the clinic or over the telephone (e.g., phone disconnected), and preterm delivery. Imputation was used to estimate the PSS score for incomplete questionnaire data if fewer than 10% of the PSS items were missing; imputation consisted of replacing the missing value with the mean of nonmissing items ($n=29$).⁸ Perceived stress scores were categorized into quartiles by using cut-points specific to each pregnancy period as prior research suggests that both the perception of a stressor as stressful and the physiologic stress response diminish as pregnancy progresses.^{15,16} The PSS is considered by some as a measure of chronic stress, which is supported by findings that PSS scores during pregnancy have been positively associated with hair cortisol, a biomarker of extended cortisol release and chronic stress.²⁶

The PSS is a validated instrument that has been found to have internal consistency (Cronbach's $\alpha=0.75$) and test-retest reliability ($r=0.55-0.85$) and to be correlated with other measures of stress.^{25,27} The Spanish version of the PSS has also demonstrated good internal consistency (Cronbach's $\alpha=0.81$), test-retest reliability ($r=0.73$), and sensitivity.²⁸

Change in stress across the duration of pregnancy was also assessed. Change in stress was examined between pregnancy periods as both (1) a continuous measure calculated as the difference in stress score between periods, and (2) a dichotomous variable indicating increase/no increase in stress.

Assessment of preterm birth, low birthweight, and SGA

Preterm birth (<37 weeks gestation) and gestational age at birth were abstracted from the medical record. Preterm birth diagnosis was based on the obstetrician's best clinical estimate of gestational age and typically determined by: (1) ultrasound if available, or (2) last menstrual period. The study obstetrician confirmed preterm birth status for all infants born ≤ 37 weeks of gestation. Birthweight was abstracted from the medical record and used to classify low birthweight infants (<2,500 g at birth). SGA was defined as a birthweight less than the 10th percentile for gestational age by using reference values from a population-based Latina sample.²⁹

Covariates

Information was collected on potential covariates that may confound the relationship between stress and preterm birth, low birthweight, or SGA. At the initial interview, information was obtained on maternal age, education, and income; whether participant was living with a partner; language preference for speaking; acculturation factors that included generation in the continental United States (born in Puerto Rico/Dominican Republic, parent born in Puerto Rico/Dominican Republic, or grandparent born in Puerto Rico/Dominican Republic) and overall acculturation level assessed via the Psychological Acculturation Scale³⁰; and current and prenatal smoking. Smoking status was updated

at subsequent interviews. Language preference determined whether the interview was conducted in English or Spanish.

Information on depressive symptoms was collected for all pregnancy periods by using the Edinburgh Postnatal Depression Scale and used to identify women with probable major depression based on validated cut-points.^{31,32} The Spielberger State-Trait Anxiety Inventory was used to assess trait anxiety in early pregnancy and state anxiety in mid- and late pregnancy.³³

Data on prepregnancy maternal weight, height, parity, history of preterm delivery, trimester of entry to prenatal care, and complications of pregnancy (gestational diabetes mellitus, preeclampsia, gestational hypertension) were obtained through the medical record. Body mass index was calculated as kg/m^2 by using self-reported height and weight. Information on antidepressant prescriptions and self-reported antidepressant use was abstracted from the electronic medical records for sensitivity analyses.

Data analysis

Baseline characteristics were compared between cases and noncases for each birth outcome. Unadjusted and multivariable logistic regression modeling was used to assess associations between perceived stress in early, mid-, and late pregnancy and preterm birth, low birthweight, and SGA. Early and mid-pregnancy perceived stress was examined in models for all birth outcomes. Late pregnancy stress was additionally examined when assessing associations with SGA; late pregnancy stress was not assessed for preterm birth and low birthweight because a number of these cases occurred before late pregnancy interviews could be conducted. Tests for trend were also conducted to determine whether there was a linear association between the PSS quartiles and the adverse birth outcomes by including the quartiles as a continuous variable in the regression model.

Known risk factors for the adverse birth outcomes included *a priori* in multivariable models included age, body mass index, parity, and history of preterm birth.³⁴⁻³⁶ Other risk factors or psychological factors were included in the final adjusted models if their inclusion changed the odds ratio (OR) for stress by more than 10%. Using this approach, smoking, depression, and anxiety were identified for inclusion. Reduced models excluding smoking, anxiety, and depression were examined as they may be on the causal pathway between stress and adverse birth outcomes.³⁷ A missing indicator category was used when more than 30 women were missing values for a given covariate for a given analysis.

Because stress is often highly correlated with other psychological factors, we assessed collinearity by examining beta coefficients of stress quartiles when anxiety and depression were included in the multivariate model, condition indices, and variance inflation values. Based on these analyses, it was determined that collinearity did not occur to the degree that would prevent the inclusion of anxiety and depression in the model. We also conducted a sensitivity analysis excluding women identified as having likely taken antidepressants as studies have found that some antidepressants may increase risk for adverse birth outcomes and high levels of stress increase risk for depression, and subsequently antidepressant use.³⁸

Change in perceived stress from early to mid-pregnancy was examined in unadjusted and adjusted analyses for each

birth outcome. Early to late pregnancy stress was also examined in models assessing associations with SGA. In addition to covariates previously identified, these analyses also adjusted for time between interviews and PSS score in early pregnancy. Analyses were conducted by using SAS version 9.2 (SAS Institute Inc, Cary, NC).

Results

Among the 1,267 participants included in the study, 9.3% had a preterm birth, 7.8% had a low birthweight infant, and 12.5% had an SGA infant (Table 1). The mean perceived stress score was 26.2 (SD=7.1) in early pregnancy, 25.2

TABLE 1. PARTICIPANT CHARACTERISTICS BY PRETERM BIRTH, LOW BIRTHWEIGHT, AND SMALL FOR GESTATIONAL AGE STATUS: PROYECTO BUENA SALUD, 2006–2011

	<i>Total sample</i> (n = 1,267)		<i>Preterm birth</i> (n = 1,267)			<i>Low birthweight</i> (n = 1,253)			<i>Small for gestational age</i> (n = 1,253)		
	n	%	n	%	p ^a	n	%	p	n	%	p
Total	1,267	100.0	118	9.3		98	7.8		158	12.6	
Maternal age											
16–19	396	31.3	41	34.8	0.38	35	35.7	0.52	54	34.2	0.31
20–24	499	39.4	38	32.2		33	33.7		67	42.4	
25–29	223	17.6	22	18.6		16	16.3		24	15.2	
≥30	149	11.8	17	14.4		14	14.3		13	8.2	
Education											
Less than high school	583	48.9	54	50.9	0.44	45	51.1	0.16	88	60.3	0.01
High school graduate or GED	386	32.4	37	34.9		33	37.5		36	24.7	
Post-high school	224	18.8	15	14.2		10	11.4		22	15.1	
Income											
Less than \$15,000	358	30.3	27	25.5	0.61	22	25.3	0.26	46	31.7	0.41
\$15,000–\$30,000	182	15.4	16	15.1		12	13.8		20	13.8	
\$30,000 or greater	75	6.4	6	5.7		3	3.5		5	3.5	
Do not know/refused	567	48.0	57	53.8		50	57.5		74	51.0	
Language preference											
English	901	75.2	80	70.1	0.37	64	69.6	0.34	111	73.0	0.55
Spanish	293	24.4	33	29.2		28	30.4		41	27.0	
Other	5	0.4	0	0.0		0	0.0		0	0.0	
Acculturation											
Low	897	79.2	80	85.1	0.14	64	82.1	0.51	109	78.4	0.82
High	236	20.8	14	14.9		14	18.0		30	21.6	
Generation in the United States											
Born in PR/DR	577	47.1	59	52.2	0.49	46	48.4	0.30	70	45.5	0.69
Parent born in PR/DR	580	47.3	49	43.4		47	49.5		77	50.0	
Grandparent born in PR/DR	69	5.6	5	4.4		2	2.1		7	4.6	
Live with partner/spouse											
No	574	48.7	48	45.7	0.52	44	50.6	0.72	71	49.0	0.96
Yes	605	51.3	57	54.3		43	49.4		74	51.0	
Prepregnancy BMI											
<18.5	78	6.2	9	7.8	0.36	8	8.3	0.13	16	10.2	0.05
18.5 to <25.0	605	48.2	53	45.7		55	56.7		81	51.6	
25.0 to <30.0	292	23.3	33	28.5		20	20.6		32	20.4	
30 or greater	281	22.4	21	18.1		14	14.4		28	17.8	
Parity											
0 live births	529	41.9	52	44.1	0.50	47	48.0	0.42	84	53.2	0.01
1 live birth	381	30.1	30	25.4		26	26.5		38	24.1	
2 or more live births	354	28.0	36	30.5		25	25.5		36	22.8	
Smoking (early pregnancy)											
No	719	85.9	70	81.4	0.20	52	83.9	0.64	73	76.0	<0.01
Yes	118	14.1	16	18.6		10	16.1		23	24.0	
Probable major depression (early pregnancy)											
No	688	82.0	75	87.2	0.18	53	85.5	0.46	73	76.0	0.10
Yes	151	18.0	11	12.8		9	14.5		23	24.0	

Numbers may not total to 1,267 due to missing data.

^ap-Values were calculated by using chi-square tests and are for comparison of distribution of covariates among cases and noncases for each adverse birth outcome.

BMI, body mass index.

TABLE 2. ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR PRENATAL PERCEIVED STRESS AND PRETERM BIRTH: PROYECTO BUENA SALUD, 2006–2011

	<i>Preterm birth</i>		<i>Unadjusted</i>		<i>Adjusted^a model</i>		<i>Reduced^b model</i>	
	n	%	OR	95% CI	OR	95% CI	OR	95% CI
Early pregnancy (<i>n</i> = 863) ^c								
First quartile	31	11.5	1.00	Ref.	1.00	Ref.	1.00	Ref.
Second quartile	20	10.5	0.90	0.50–1.63	0.91	0.46–1.77	0.93	0.49–1.74
Third quartile	16	7.7	0.64	0.34–1.21	0.75	0.36–1.60	0.69	0.36–1.33
Fourth quartile	19	9.6	0.82	0.45–1.50	1.38	0.59–3.22	0.93	0.49–1.75
<i>p</i> _{trend}				0.32		0.74		0.57
Mid-pregnancy (<i>n</i> = 794) ^c								
First quartile	14	6.5	1.00	Ref.	1.00	Ref.	1.00	Ref.
Second quartile	17	8.7	1.36	0.65–2.85	1.78	0.77–4.12	1.37	0.63–2.97
Third quartile	22	11.3	1.82	0.90–3.66	2.41	1.04–5.60	1.73	0.83–3.61
Fourth quartile	20	10.5	1.68	0.82–3.43	3.50	1.38–8.87	1.95	0.93–4.09
<i>p</i> _{trend}				0.11		<0.01		0.06

^aAdjusted for maternal age, BMI, parity, history of PTB, smoking, anxiety, and probable major depression.

^bAdjusted for maternal age, BMI, parity, and history of PTB.

^cPSS scores—early pregnancy: Q1 = ≤ 22, Q2 = > 22 and ≤ 26, Q3 = > 26 and ≤ 31, Q4 = > 31; mid-pregnancy: Q1 = ≤ 20, Q2 = > 20 and ≤ 25, Q3 = > 25 and ≤ 30, Q4 = > 30.

CI, confidence interval; OR, odds ratio; PSS, Perceived Stress Scale.

(SD=7.3) in mid-pregnancy, and 23.3 (SD=7.8) in late pregnancy. Overall, the mean age of participants was 22.8 years. Women were generally of low socioeconomic status, with 48.8% of women reporting that they did not receive a high school diploma or GED. Almost half of all women were born in Puerto Rico/Dominican Republic. Eighteen percent of women were classified as having probable major depression in early pregnancy. None of the baseline participant characteristics were associated with preterm birth or low birthweight. Women who had lower levels of education or who were underweight, nulliparous, or smoked in early pregnancy were significantly more likely to have an infant born SGA.

Early pregnancy perceived stress was not associated with preterm birth in adjusted or unadjusted models (Table 2). However, mid-pregnancy stress increased risk for preterm

birth upon adjustment for risk factors, with women in the highest quartile of stress experiencing more than three times the risk of preterm birth compared with women in the lowest quartile (OR = 3.50, confidence interval [95% CI]: 1.38–8.87, *p*_{trend} = <0.01). A similar trend was observed in the reduced model that did not include adjustment for smoking, anxiety, or depression, though the associations were attenuated and no longer statistically significant (*p*_{trend} = 0.06).

Similar to preterm birth analysis findings, a positive linear association was observed between mid-pregnancy stress and low birthweight, with women in the highest quartile experiencing more than three times the risk of low birthweight compared with women in the lowest quartile of stress in adjusted analyses (OR = 3.53, 95% CI = 1.27–9.86, *p*_{trend} = 0.01) (Table 3). Results were similar in the reduced

TABLE 3. ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR PRENATAL PERCEIVED STRESS AND LOW BIRTHWEIGHT: PROYECTO BUENA SALUD, 2006–2011

	<i>Low birthweight</i>		<i>Unadjusted</i>		<i>Adjusted^a model</i>		<i>Reduced^b model</i>	
	n	%	OR	95% CI	OR	95% CI	OR	95% CI
Early pregnancy (<i>n</i> = 854) ^c								
First quartile	20	7.5	1.00	Referent	1.00	Referent	1.00	Referent
Second quartile	18	9.7	1.33	0.68–2.59	1.70	0.81–3.58	1.55	0.77–3.12
Third quartile	13	6.3	0.84	0.41–1.72	1.18	0.50–2.79	0.93	0.44–1.99
Fourth quartile	12	6.1	0.80	0.38–1.68	1.64	0.60–4.50	0.99	0.46–2.15
<i>p</i> _{trend}				0.39		0.47		0.75
Mid-pregnancy (<i>n</i> = 787) ^c								
First quartile	10	4.7	1.00	Referent	1.00	Referent	1.00	Referent
Second quartile	11	5.8	1.24	0.52–2.99	1.67	0.63–4.42	1.46	0.58–3.67
Third quartile	18	9.2	2.05	0.92–4.57	2.59	1.01–6.69	2.20	0.95–5.11
Fourth quartile	18	9.5	2.11	0.95–4.70	3.53	1.27–9.86	2.62	1.13–6.06
<i>p</i> _{trend}				0.03		0.01		0.01

^aAdjusted for maternal age, BMI, parity, history of PTB, smoking, anxiety, and probable major depression.

^bAdjusted for maternal age, BMI, parity, and history of PTB.

^cPSS scores—early pregnancy: Q1 = ≤ 22, Q2 = > 22 and ≤ 26, Q3 = > 26 and Q4 = > 31; mid-pregnancy: Q1 = ≤ 20, Q2 = > 20 and ≤ 25, Q3 = > 25 and ≤ 30, Q4 = > 30.

TABLE 4. ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR PRENATAL PERCEIVED STRESS AND SMALL FOR GESTATIONAL AGE: PROYECTO BUENA SALUD, 2006–2011

	<i>Small for gestational age</i>		<i>Unadjusted</i>		<i>Adjusted^a model</i>		<i>Reduced^b model</i>	
	<i>n</i>	<i>%</i>	<i>OR</i>	<i>95% CI</i>	<i>OR</i>	<i>95% CI</i>	<i>OR</i>	<i>95% CI</i>
Early pregnancy (<i>n</i> = 854) ^c								
First quartile	28	10.5	1.00	Referent	1.00	Referent	1.00	Referent
Second quartile	26	14.1	1.40	0.79–2.47	1.54	0.81–2.93	1.37	0.77–2.47
Third quartile	25	12.2	1.19	0.67–2.10	1.44	0.71–2.93	1.15	0.64–2.08
Fourth quartile	22	11.2	1.07	0.59–1.94	0.98	0.41–2.34	0.99	0.63–1.83
<i>p</i> _{trend}				0.87		0.91		0.90
Mid-pregnancy (<i>n</i> = 787) ^c								
First quartile	27	12.7	1.00	Referent	1.00	Referent	1.00	Referent
Second quartile	20	10.5	0.81	0.44–1.49	0.90	0.46–1.74	0.86	0.46–1.63
Third quartile	25	12.8	1.01	0.56–1.80	0.98	0.49–1.96	1.07	0.58–1.97
Fourth quartile	22	11.6	0.90	0.49–1.64	0.65	0.29–1.47	0.90	0.48–1.70
<i>p</i> _{trend}				0.89		0.39		0.91
Late pregnancy (<i>n</i> = 759) ^c								
First quartile	27	13.9	1.00	Referent	1.00	Referent	1.00	Referent
Second quartile	19	9.6	0.66	0.35–1.23	0.70	0.36–1.37	0.69	0.36–1.31
Third quartile	16	9.0	0.61	0.32–1.18	0.60	0.28–1.26	0.62	0.32–1.22
Fourth quartile	32	16.9	1.26	0.72–2.20	0.96	0.44–2.08	1.16	0.64–2.09
<i>p</i> _{trend}				0.43		0.72		0.66

^aAdjusted for maternal age, BMI, parity, history of PTB, smoking, anxiety, and probable major depression.

^bAdjusted for maternal age, BMI, parity, and history of PTB.

^cPSS scores—early pregnancy: Q1 = ≤ 22, Q2 = > 22 and ≤ 26, Q3 = > 26 and ≤ 31, Q4 = > 31; mid-pregnancy: Q1 = ≤ 20, Q2 = > 20 and ≤ 25, Q3 = > 25 and ≤ 30, Q4 = > 30; late pregnancy: Q1 = ≤ 18, Q2 = > 18 and ≤ 23, Q3 = > 23 and ≤ 28, Q4 = > 28.

model ($p_{\text{trend}} = 0.01$), though somewhat attenuated. Early pregnancy stress was not associated with low birthweight. Early, mid-, and late pregnancy perceived stress levels were not found to be associated with SGA in unadjusted or adjusted analyses (Table 4).

We then conducted a sensitivity analysis that excluded women ($n = 31$) who were prescribed or reported taking antidepressants as antidepressant use may confound the association between stress and adverse birth outcomes. Results were unchanged.

Upon evaluation of the associations between change in perceived stress during pregnancy and adverse birth outcomes, we did not observe significant associations between an increase in stress from early to mid-pregnancy and risk of preterm birth or low birthweight (results not shown). However, women who experienced an increase in stress from early to late pregnancy had a 90% increased risk of SGA

compared with women whose stress did not increase in adjusted analysis (OR = 1.90, 95% CI = 1.01–3.59) (Table 5). Though the estimate of effect was elevated when examining the association between a one-unit increase in PSS score during this timeframe and SGA, the findings were not significant (OR = 1.04, 95% CI: 0.99–1.09).

Lastly, women missing stress information did not differ on any sociodemographic characteristics from those not missing stress information. However, women missing early pregnancy stress data had higher levels of trait anxiety than those not missing these data (25.7% vs. 19.9% in the top quartile of anxiety).

Discussion

In this prospective cohort study of predominantly Puerto Rican women, those with high levels of perceived stress in

TABLE 5. ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR CHANGE IN PERCEIVED STRESS SCALE SCORE FROM EARLY TO LATE PREGNANCY AND SMALL FOR GESTATIONAL AGE: PROYECTO BUENA SALUD, 2006–2011

	<i>Small for gestational age</i>		<i>Unadjusted</i>		<i>Adjusted^a</i>	
	<i>n</i>	<i>%</i>	<i>OR</i>	<i>95% CI</i>	<i>OR</i>	<i>95% CI</i>
Change in stress (continuous) ^b	55	11.2	1.02	0.98–1.06	1.04	0.99–1.09
Increase in stress ^c						
No	33	9.7	1.00	Referent	1.00	Ref.
Yes	22	14.6	1.60	0.90–2.84	1.90	1.01–3.59

Women with information on change in stress from early to late pregnancy $n = 493$.

^aAdjusted for maternal age, prepregnancy BMI, parity, history of PTB, smoking, and PSS in early pregnancy.

^bOne-unit change in PSS score.

^cIncrease in PSS (increase/no increase).

mid-pregnancy experienced three times the risk of preterm birth and low birthweight compared with women with low levels of stress. In addition, women who experienced an increase in stress from early to late pregnancy experienced almost double the risk of SGA compared with women who did not. Stress in early, mid-, and late pregnancy was not associated with SGA.

Our findings that greater levels of stress increased the risk for preterm birth and low birthweight are similar to those of several other studies,⁷⁻⁹ though not all studies have found this association.^{10,11} Conflicting findings are likely due to differences in the stress assessment measure used and timing of the assessment of stress. For example, some studies used life events or daily hassle measures that assess the occurrence of stressful events, but do not take into account buffers of stress and the perception of stressors as stressful, which is accounted for in the PSS.²⁷

The need to account for stress buffering factors and individual differences in the appraisal of potentially stressful events as stressful was illustrated in the study by Dole et al. Specifically, in this prospective cohort study conducted among 1,962 women in North Carolina, the authors found that life events or external stressors increased risk for preterm birth only when perception of these events was taken into account (OR=1.80, 95% CI: 1.2-2.7).⁸ In models that adjusted for anxiety and depression, our findings persisted and tended to be more pronounced, suggesting that aspects of perceived stress not shared with depression and anxiety may increase risk for preterm birth and low birthweight.

Our findings that stress at individual time points during pregnancy was not associated with SGA are consistent with the majority of studies examining this association.^{7,10} However, we found that an increase in stress from early to late pregnancy increased risk for SGA. Few studies have examined the effects of change in stress on adverse birth outcomes, and those that have been conducted focused on preterm birth/gestational age.^{15,17} Increases in stress over the course of pregnancy have been theorized to indicate a susceptibility to stress, as research suggests that both the physiologic stress response and the appraisal of experiences as stressful diminish as pregnancy progresses.¹⁵ We did not observe significant associations between increase in stress from early to mid-pregnancy and any of the adverse birth outcomes. Studies that have found an association between increase in stress and preterm birth/gestational age focused on change in stress from mid- to late pregnancy.^{15,17}

PBS focused on women of "Caribbean Island" descent, which included both Puerto Ricans and Dominicans as designated by the U.S. Census.²⁴ Our study did not differentiate between island of descent; however, U.S. census data indicate that 93.2% of citizens of Caribbean heritage in Springfield, Massachusetts, are of Puerto Rican origin.³⁹

Several theories explain how elevated levels of psychosocial stress may increase risk for early parturition and growth restriction. Psychosocial stress may lead to prematurely elevated levels of CRH, which is believed to play a role in the initiation of parturition.⁴⁰ Some studies have found increased levels of CRH among women with preterm births as compared with term births.^{41,42} Another theory suggests that the release of stress hormones cortisol, norepinephrine, and epinephrine may increase risk for infection,⁴³ which is one of the major risk factors for preterm birth.^{35,40} Nor-

epinephrine may also lead to reduced uterine blood flow and subsequent nutritive delivery to the fetus,^{40,44} which, under chronically elevated conditions, could lead to fetal growth restriction. Some studies also suggest that elevated maternal cortisol levels may inhibit fetal growth.³

Elevated stress levels are also associated with a higher prevalence of unhealthy behaviors, such as smoking and inadequate nutrition, both of which have been identified as potential risk factors for preterm birth and growth restriction.^{42,45} Finally, stress may impact utilization of prenatal care and adherence to healthcare provider recommendations during pregnancy.

Exposure to chronic stress may also impact associations between stress and adverse birth outcomes as a growing body of research in animal models and humans suggest that the effects of stress may vary depending on the chronicity of stress.⁴⁶ Animal research suggests that exposure to chronic stress leads to a dysregulation of the HPA axis and a blunted physiologic stress response over time.⁴⁶ Studies in animals and humans have also found that though there is a habituation to chronic stressors, there may also be an increased sensitivity and reactivity to new stressors.^{46,47} In addition, evidence from animal and human studies suggest that lower levels of glucocorticoids may have more pronounced effects on body systems among chronically stressed individuals.⁴⁶

Chronically stressed women may also engage in behaviors that increase risk for adverse birth outcomes. Though we found that stress was associated with adverse birth outcomes after adjusting for smoking, it is possible that other behaviors associated with stress may increase risk. The predominantly Puerto Rican Latina women included in this study were primarily of low socioeconomic status (SES) and have likely experienced high levels of chronic stress as reflected in the high mean PSS scores (early pregnancy mean=26.2, SD=7.1) when compared with women (mean=20.2, SD=7.8) or Latinas (mean=21.3, SD=7.8) in a general U.S. probability sample.²⁵ However, the U.S. probability sample included Latina women of multiple Latina subgroups combined; to our knowledge, a PSS probability sample mean is not available for Puerto Rican women specifically.

In studying our population of pregnant Latina (predominantly Puerto Rican) women, we are focusing on a combination of race, ethnicity, and descent. Consistent with this approach, the Pew Research Center has found that a large proportion of Hispanics/Latinos do not identify with the construct of race, selecting "some other race" rather than "White" or "Black" (37% in 2010 U.S. Census).⁴⁸ In addition, in a survey of multi-racial Americans, two-thirds of Hispanics thought that their Hispanic background was part of their racial background.⁴⁸ In response to these findings indicating a differing view of "race" among Hispanics, the U.S. Census is considering a combined race and ethnicity question for the 2020 U.S. Census (*i.e.*, response options of: Hispanic/Latino, White, Black, etc.).⁴⁹

Our approach is consistent with the prior literature identifying racial and ethnic disparities in birth outcomes. Specifically, in this literature, non-Latina Whites are compared with non-Latina Blacks, and Latinas to understand disproportionate impacts among differing communities of color.⁵⁰⁻⁵² Because birth outcome disparities among Latinas are obscured when examining Latinas as a whole, the prior literature has also examined descent. For example, in the case of preterm birth,

rates are only slightly higher than non-Latina Whites when examining Latinas as a whole (12.3% vs. 11.5%), but become more pronounced when Latina women are stratified by descent with Puerto Rican women experiencing the highest rates among Latinas and one of the highest rates overall (14.5%).²

Our study had several potential limitations. When using the PSS to assess perceived stress, there is likely individual variability in one's willingness to answer affirmative to some PSS questions, such as feeling "out of control," which could lead to nondifferential misclassification of stress. In addition, though the Spanish version of the PSS has demonstrated good reliability in a European Spanish population, the instrument has not been validated in a Puerto Rican population or Spanish-speaking population in the United States. Research has shown that reliability of the scale may vary across Spanish-speaking populations of differing descent, likely due to differences in interpreting the questions.⁵³ These sources of nondifferential misclassification of stress would have led to an underestimation of our findings.

Though we were able to adjust for a number of important confounders, we did not have complete information on utilization of prenatal care, which may be impacted by stress levels or factors that contribute to stress and may also be associated with adverse birth outcomes. However, we anticipate that the majority of study participants received adequate prenatal care because an estimated 76.4% of pregnant Latina women in Springfield, MA, receive adequate prenatal care as defined by the Adequacy of Prenatal Care Utilization (APNCU) Index, which takes into account number of prenatal visits.⁵⁴ In addition, it is also possible that findings might vary by the preferred language of the participant. However, because the majority of women spoke English with few women speaking Spanish, we were unable to assess whether findings differed between Spanish and English speakers.

We did not have complete stress information for all women at all pregnancy periods. It is possible that woman experiencing high stress did not participate in all of the interviews as a result of their stress. When comparing sociodemographic characteristics between women with and without stress information for each pregnancy period, no significant differences were observed. However, we did find higher levels of trait anxiety among women who did not have early pregnancy stress data. To the extent that women missing early pregnancy stress may have had higher stress levels, this could have underestimated associations for early pregnancy stress. In addition, we were unable to assess the association between late pregnancy stress and risk of preterm birth and low birthweight because a number of women gave birth before the late pregnancy interview could be conducted.

In summary, we found that elevated levels of perceived stress in mid-pregnancy increased risk for preterm birth and low birthweight in a high-risk population of predominantly Puerto Rican women who have been exposed to chronic stressors. In addition, women who experienced an increase in stress over the course of pregnancy were at increased risk of giving birth to an SGA infant. These findings can be used to inform screening efforts to identify high-risk women who have elevated levels of perceived stress in mid-pregnancy or who experience an increase in stress across pregnancy so that they can receive targeted interventions to reduce risk for these adverse birth outcomes. Additional screening of women with high stress levels to identify psychosocial risk factors contributing to

high levels of stress (*e.g.*, housing instability, food insecurity, domestic violence) can be used to identify areas of need that may be addressed through case management or referral.

Though the American College of Obstetrics and Gynecology recommends psychosocial risk factor screening during pregnancy, it has not routinely been incorporated into practice.⁵⁵ In many cases, the availability of programs to address these psychosocial risk factors or social determinants of health is limited.⁵⁶ Recent studies indicate that sources of prenatal stress among Latina women in Massachusetts include financial concerns, the need to move, relationship issues, and physical health problems.⁵⁷ Additional policies and resources are needed to support programs and interventions to address social determinants of health.⁵⁶ Research also suggests that stress management and coping skills training may effectively be used to reduce stress levels when combined with efforts to address psychosocial stressors, though more research is needed to understand the most effective strategies, particularly as they relate to diverse populations.^{3,58}

Acknowledgment

This study was supported by NIH grant DK064902 from the National Institute of Diabetes and Digestive and Kidney Diseases.

Author Disclosure Statement

No competing financial interests exist.

References

1. Mathews TJ, MacDorman M. Infant mortality statistics from the 2007 period linked birth/infant death data set. *Natl Vital Stat Rep* 2011;59:1–30.
2. MacDorman M. Race and ethnic disparities in fetal mortality, preterm birth, and infant mortality in the United States: An overview. *Semin Perinatol* 2011;35:200–208.
3. Hobel C, Goldstein A, Barrett E. Psychosocial stress and pregnancy outcome. *Clin Obstet Gynecol* 2008;51:333–348.
4. Wadhwa P, Glynn L, Hobel C, et al. Behavioral perinatology: Biobehavioral processes in human fetal development. *Regul Pept* 2002;108:149–157.
5. Motel S, Patten E. Hispanics of Puerto Rican Origin in the United States, 2010. Pew Research Center. 2012. Available at: www.pewhispanic.org/2012/06/27/hispanics-of-puerto-rican-origin-in-the-united-states-2010 Accessed August 24, 2016.
6. Zsembik B, Fennell D. Ethnic variation in health and the determinants of health among Latinos. *Soc Sci Med* 2005; 61:53–63.
7. Copper RL, Goldenberg RL, Das A, et al. The preterm prediction study: Maternal stress is associated with spontaneous preterm birth at less than thirty-five weeks' gestation. National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network. *Obstet Gynecol* 1996;175:1286–1292.
8. Dole N, Savitz DA, Hertz Picciotto I, Siega Riz AM, McMahon MJ, Buekens P. Maternal stress and preterm birth. *Am J Epidemiol* 2003;157:14–24.
9. Ghosh JKC, Wilhelm M, Dunkel Schetter C, Lombardi C, Ritz B. Paternal support and preterm birth, and the moderation of effects of chronic stress: A study in Los Angeles county mothers. *Arch Women's Ment Health* 2010;13: 327–338.

10. Krabbendam L, Smits L, de Bie R, Bastiaanssen J, Stelma F, van Os J. The impact of maternal stress on pregnancy outcome in a well-educated Caucasian population. *Paediatr Perinat Epidemiol* 2005;19:421–425.
11. Kramer M, Lydon J, Sguin L, et al. Stress pathways to spontaneous preterm birth: The role of stressors, psychological distress, and stress hormones. *Am J Epidemiol* 2009;169:1319–1326.
12. Paarlberg KM, Vingerhoets AJ, Passchier J, Dekker GA, Heinen AG, van Geijn HP. Psychosocial predictors of low birthweight: A prospective study. *Br J Obstet Gynaecol* 1999;106:834–841.
13. Lau Y. The effect of maternal stress and health-related quality of life on birth outcomes among Macao Chinese pregnant women. *J Perinat Neonatal Nurs* 2013;27:14–24.
14. Roy-Matton N, Moutquin J, Brown C, Carrier N, Bell L. The impact of perceived maternal stress and other psychosocial risk factors on pregnancy complications. *J Obstet Gynaecol Can* 2011;33:344–352.
15. Glynn L, Schetter C, Hobel C, Sandman C. Pattern of perceived stress and anxiety in pregnancy predicts preterm birth. *Health Psychol* 2008;27:43–51.
16. Wadhwa PD, Entringer S, Buss C, Lu MC. The contribution of maternal stress to preterm birth: Issues and considerations. *Clin Perinatol* 2011;38:351–384.
17. Ruiz RJ, Fullerton J, Brown CE, Schoolfield J. Relationships of cortisol, perceived stress, genitourinary infections, and fetal fibronectin to gestational age at birth. *Biol Res Nurs* 2001;3:39–48.
18. Dunkel Schetter C, Tanner L. Anxiety, depression and stress in pregnancy: Implications for mothers, children, research, and practice. *Curr Opin Psychiatry* 2012;25:141–148.
19. Campos B, Schetter C, Abdou C, Hobel C, Glynn L, Sandman C. Familialism, social support, and stress: Positive implications for pregnant Latinas. *Cultur Divers Ethnic Minor Psychol* 2008;14:155–162.
20. Rondó PHC, Ferreira RF, Nogueira F, Ribeiro MCN, Lobert H, Artes R. Maternal psychological stress and distress as predictors of low birth weight, prematurity and intrauterine growth retardation. *Eur J Clin Nutr* 2003;57:266–272.
21. Wadhwa PD, Sandman CA, Porto M, Dunkel Schetter C, Garite TJ. The association between prenatal stress and infant birth weight and gestational age at birth: A prospective investigation. *Obstet Gynecol* 1993;169:858–865.
22. Pryor JE, Thompson JMD, Robinson E, et al. Stress and lack of social support as risk factors for small-for-gestational-age birth. *Acta paediatr* 2003;92:62–64.
23. Ruiz RJ, Dolbier C, Fleschler R. The relationships among acculturation, biobehavioral risk, stress, corticotropin-releasing hormone, and poor birth outcomes in Hispanic women. *Ethn Dis* 2006;16:926–932.
24. Chasan-Taber L, Fortner R, Gollenberg A, Buonnaccorsi J, Dole N, Markenson G. A prospective cohort study of modifiable risk factors for gestational diabetes among Hispanic women: Design and baseline characteristics. *J Women's Health (Larchmt)* 2010;19:117–124.
25. Cohen S, Williamson G. Perceived stress in a probability sample of the U.S. In: Spacapan S, Oskamp S, eds. *The social psychology of health: Claremont Symposium on Applied Social Psychology*. Newbury Park, CA: Sage, 1988.
26. Kalra S, Einarson A, Karaskov T, Van Uum S, Koren G. The relationship between stress and hair cortisol in healthy pregnant women. *Clin Invest Med* 2007;30:E103–E107.
27. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983;24:385–396.
28. Remor E. Psychometric properties of a European Spanish version of the Perceived Stress Scale (PSS). *The Span J Psychol* 2006;9:86–93.
29. Alexander GR, Kogan MD, Himes JH. 1994–1996 U.S. singleton birth weight percentiles for gestational age by race, Hispanic origin, and gender. *Matern Child Health J* 1999;3:225–231.
30. Tropp L, Erkut S, Coll C, Alarcón O, Vazquez-García H. Psychological acculturation: Development of a new measure for Puerto Ricans on the U.S. mainland. *Educ Psychol Meas* 1999;59:351–367.
31. Matthey S, Henshaw C, Elliott S, Barnett B. Variability in use of cut-off scores and formats on the Edinburgh Postnatal Depression Scale: Implications for clinical and research practice. *Arch Womens Ment Health* 2006;9:309–315.
32. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *Br J Psychiatry* 1987;150:782–786.
33. Spielberger CD. *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press, 1983.
34. Valero De Bernabe J, Soriano T, Albaladejo R, et al. Risk factors for low birth weight: A review. *Eur J Obstet Gynecol Reprod Biol* 2004;116:3–15.
35. Goldenberg R, Culhane J, Iams J, Romero R. Epidemiology and causes of preterm birth. *Lancet* 2008;371:75–84.
36. McCowan L, Horgan R. Risk factors for small for gestational age infants. *Best Pract Res Clin Obstet Gynaecol* 2009;23:779–793.
37. Bados A, Gómez-Benito J, Balaguer G. The state-trait anxiety inventory, trait version: Does it really measure anxiety? *J Pers Assess* 2010;92:560–567.
38. Udechuku A, Nguyen T, Hill R, Szego K. Antidepressants in pregnancy: A systematic review. *Aust N Z J Psychiatry* 2010;44:978–996.
39. U.S. Census Bureau. 2009–2013. American community survey 5 year estimates. Available at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_B03001&prodType=table Accessed August 27, 2015.
40. Hobel C. Stress and preterm birth. *Clin Obstet Gynecol* 2004;47:856–880.
41. Hobel CJ, Dunkel Schetter C, Roesch SC, Castro LC, Arora CP. Maternal plasma corticotropin-releasing hormone associated with stress at 20 weeks' gestation in pregnancies ending in preterm delivery. *Obstet Gynecol* 1999;180:S257–S263.
42. Dunkel Schetter C, Glynn LM. Stress in pregnancy: Empirical evidence and theoretical issues to guide interdisciplinary research. In: Contrada R, Baum A, eds. 1st ed. New York: Springer Publishing Company, 2011:321–343.
43. Wadhwa PD, Culhane JF, Rauh V, et al. Stress, infection and preterm birth: A biobehavioural perspective. *Paediatr Perinat Epidemiol* 2001;15 Suppl 2:17–29.
44. Katz VL, Jenkins T, Haley L, Bowes WA. Catecholamine levels in pregnant physicians and nurses: A pilot study of stress and pregnancy. *Obstet Gynecol* 1991;77:338–342.
45. Dunkel Schetter C. Psychological science on pregnancy: Stress processes, biopsychosocial models, and emerging research issues. *Annu Rev Psychol* 2011;62:531–558.
46. Herman J. Neural control of chronic stress adaptation. *Front Behav Neurosci* 2013;7:61.

47. Rich Edwards JG, Grizzard T. Psychosocial stress and neuroendocrine mechanisms in preterm delivery. *Obstet Gynecol* 2005;192:S30–S35.
48. Gonzalez-Barrera A, Lopez M. Is being Hispanic a matter of race, ethnicity, or both? Pew Research Center. 2015. Available at: www.pewresearch.org/fact-tank/2015/06/15/is-being-hispanic-a-matter-of-race-ethnicity-or-both Accessed June 15, 2017.
49. U.S. Census Bureau. Research to improve data on race and ethnicity. 2017. Available at: www.census.gov/about/our-research/race-ethnicity.html Accessed June 15, 2017.
50. Institute of Medicine. Preterm birth: Causes, consequences, and prevention. Washington, DC: The National Academies Press, 2007. <https://doi.org/10.17226/11622> Accessed June 1, 2017.
51. Institute of Medicine. Unequal treatment: Confronting racial and ethnic disparities in health care (full printed version). Washington, DC: The National Academies Press, 2003. <https://doi.org/10.17226/10260> Accessed June 1, 2017.
52. Williams D. Miles to go before we sleep: Racial inequities in health. *J Health Soc Behav* 2012;53:279–295.
53. Ramirez M, Gonzalez T, Hernandez R. Factor structure of the Perceived Stress Scale (PSS) in a sample from Mexico. *Span J Psychol* 2007;10:199–206.
54. Massachusetts Department of Public Health. MassCHIP. 2012.
55. Spyridou A, Schauer M, Ruf Leuschner M. Obstetric care providers assessing psychosocial risk factors during pregnancy: Validation of a short screening tool—The KINDEX Spanish Version. *Child Adolesc Psychiatry Ment Health* 2014;8:30.
56. Adler NE, Cutler DM, Fielding J, et al. Addressing social determinants of health and health disparities. Discussion Paper, Vital Directions for Health and Health Care Series. Washington, DC: National Academy of Medicine, 2016. Available at: <https://nam.edu/wp-content/uploads/2016/09/addressing-social-determinants-of-health-and-health-disparities.pdf> Accessed June 1, 2017.
57. Liu C, Giallo R, Doan S, Seidman L, Tronick E. Racial and ethnic differences in prenatal life stress and postpartum depression symptoms. *Arch Psychiatr Nurs* 2016;30:7–12.
58. Guardino C, Schetter C. Coping during pregnancy: A systematic review and recommendations. *Health Psychol Rev* 2014;8:70–94.

Address correspondence to:

Kathleen Szegda, PhD

Department of Biostatistics and Epidemiology

School of Public Health and Health Sciences

University of Massachusetts

414 Arnold House

715 North Pleasant Street

Amherst, MA 01003-9304

E-mail: kszegda@umass.edu