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Prenatal Depression and Risk of Short Interpregnancy Interval in a Predominantly Puerto Rican Population

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Abstract

Background: Short interpregnancy interval (IPI) is associated with risk of adverse pregnancy outcomes; however, few studies have evaluated the role of depression as a risk factor for short IPI. Puerto Rican women in the United States experience disparities in adverse birth outcomes and have the highest birth rates.
Methods: We analyzed the association between prenatal depressive symptoms and IPI in Proyecto Buena Salud, a prospective cohort of predominantly Puerto Rican women in Western Massachusetts (2006–2011). Depression was measured using the Edinburgh Postnatal Depression Scale (EPDS) in early, mid, and late pregnancy. We calculated follow-up time as the difference between the date of delivery of the index pregnancy and the last menstrual period of the subsequent pregnancy using medical records and billing data. We defined short IPI as ≤18 months.
Results: Of 1262 eligible women, 35% ($n = 440$) had at least probable minor depression (EPDS scores ≥13) and 25% ($n = 315$) had probable major depression (EPDS scores ≥15). Participants were followed for a median of 3.7 years (interquartile range = 1.4–6.0 years) and 240 (20.6%) participants experienced a short IPI. After adjusting for risk factors, women with probable minor depression (adjusted odds ratio [aOR] = 1.39, 95% confidence interval [CI] = 1.02–1.88) and probable major depression (aOR = 1.42, 95% CI = 1.02–1.97) during pregnancy had increased odds of short IPI.
Conclusions: Prenatal depressive symptoms were common in this Puerto Rican population and were associated with a modest increase in odds of short IPI. Further examination of the pathways through which mental health may affect IPI in vulnerable populations is warranted.

Keywords: prenatal depression, pregnancy interval, depressive symptoms, postpartum period, Hispanic perinatal health

Introduction

Interpregnancy interval (IPI) is the length of time between the delivery of a live birth and the start of the subsequent pregnancy.[1] Short IPI (≤18 months) has been associated with increased risk of adverse maternal and perinatal outcomes such as preterm birth, low birth weight, small for gestational age, preeclampsia, and maternal death.[2–4] Puerto Rican women living in the continental United States experience disparities in these adverse birth outcomes and correspondingly, have one of the highest infant mortality rates in the United States.[5] This is critical as Hispanics are the largest and fastest growing ethnic minority group in the United States.[6] Among Hispanics, Puerto Ricans are the second largest subgroup[7] and have the highest birth rates in the United States.[8] Therefore, it is important to identify modifiable risk factors for short IPI in this high-risk population.

Previous studies have largely focused on nonmodifiable risk factors for short IPI. These studies have found that young maternal age, ethnic minority status, low socioeconomic status, and high parity increase the risk.[9–11] In contrast, the impact of maternal mental health on IPI remains largely unexplored. Depression affects ~1 in 10 women of

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reproductive age in the United States, with a prevalence of 7%–20% during pregnancy.[12] Hispanic women are at increased risk for depression during pregnancy with some studies finding estimates of probable depression during pregnancy as high as 53% among Hispanic populations,[13] and Puerto Ricans having the highest lifetime prevalence of depression.[6]

Prenatal depression may affect IPI through several pathways, although data are sparse. First, depression may lie on the causal pathway between interpersonal violence and trauma (*e.g.*, physical abuse) during pregnancy and subsequent risk of short IPI. Previous studies have found that these adverse experiences during pregnancy contribute to short IPI and prenatal depression.[14–16] Second, depression may be associated with short IPI through its association with low educational status and the inconsistent use of medications including contraception thereby leading to unintended pregnancy.[17] Supporting this hypothesis are studies that identified more inconsistent oral contraceptive use in women with mild-to-moderate depressive symptoms.[18,19]

However, previous epidemiologic studies evaluating the association between depression and IPI have been largely limited to adolescent populations,[16,17,20–23] with only one, to our knowledge, focused on adult women.[17] These studies were limited by small sample sizes, short follow-up time periods, and were conducted among predominantly non-Hispanic white populations. 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, therefore potentially misclassifying mothers whose depression occurred at an earlier or later pregnancy time point. Others only relied upon postpartum measures of depression or only evaluated unintended pregnancy.[17,21]

Findings of an association between depression and short IPI would provide key opportunities for interventions designed to benefit both the mother and her offspring and be of practical value for service providers in terms of program planning and service provision. Therefore, our objective was to evaluate the association between depressive symptoms during pregnancy and IPI among a predominantly Puerto Rican population in Western Massachusetts from 2006 to 2016. To our knowledge, this is the first study to evaluate the association between prenatal depression and IPI among Hispanics.

Methods

Study design

We evaluated the association between depressive symptoms during pregnancy and IPI among participants in Proyecto Buena Salud (PBS), a prospective cohort study of psychosocial stress, physical activity, and risk of gestational diabetes among predominantly Puerto Rican prenatal care patients at Baystate Medical Center (BMC), an academic medical center and the only tertiary care hospital in Western Massachusetts, from 2006 to 2011. Details of PBS have been previously published.[24] Bilingual interviewers recruited patients at a prenatal care visit early in pregnancy (up to 20 weeks gestation), informed them of the aims and procedures of the study, and obtained written informed consent as approved by the institutional review boards of the University of Massachusetts-Amherst and Baystate Health. Interviews were conducted in Spanish or English (based on patient preference) to eliminate potential language or literacy barriers.

Eligibility was restricted to Caribbean Islanders (*i.e.*, women of Puerto Rican or Dominican Republic ancestry) defined according to the U.S. census as women (1) born on these islands; or (2) who had at least one parent or two grandparents born on these islands. Prescreening criteria also ruled out patients for consideration who had: (1) current medications thought to adversely influence glucose tolerance (*e.g.*, prednisone), (2) multiple gestation, (3) pregestational diabetes, hypertension, heart disease, or chronic renal disease, and (4) <16 years and >40 years of age. A total of 1627 participants were enrolled into PBS. For this analysis, we excluded 85 participants whose index pregnancy ended in a miscarriage or stillbirth, 171 women who had missing data on depressive symptoms during the index pregnancy, and 109 women who were missing the delivery date of the index pregnancy. Therefore, the final analytic sample included 1262 women.

For the purposes of the current analyses, we additionally excluded women whose index pregnancy ended in a miscarriage or stillbirth, who had missing data on depressive symptoms during the index pregnancy, or were missing the delivery date of the index pregnancy.

Assessment of depression

Bilingual interviewers administered the 10-item Edinburgh Postnatal Depression Scale (EPDS) in either English[25] or Spanish[26] at the time of enrollment (early pregnancy = <20 weeks gestation) and again in mid (mean = 21.3 weeks gestation) and late (mean = 30.8 weeks gestation) pregnancy. The EPDS consists of 10 items asking respondents to indicate how frequently they have felt various mood states during the past 7 days. Examples of items on the EPDS include, ''I have been so unhappy that I have been crying'' and ''Things have been getting on top of me.'' Responses are on a 4-point scale ranging from ''no, never'' to ''yes, most of the time'' with corresponding scores of 0 (never) to 3 (most of the time). Scores are summed with total scores ranging from 0 to 30.

Based on recommendations from a systematic review, scores ≥13 at any of the three pregnancy time points (*i.e.*, early, mid, and late pregnancy) were used to define ''at least probable minor depression'' and those 15 or more at any of the three pregnancy time points were used to define ''probable major depression.''[27] We also averaged EPDS scores over the three pregnancy time points to derive a continuous EPDS measure.

Prenatal EPDS scores of 15 or more have been correlated with clinically diagnosed major depression disorder with 100% sensitivity and 96% specificity.[28] The EPDS has been validated among antepartum and postpartum women.[29] It also has been validated among Spanish-speaking mothers[30] and validated as an appropriate use for screening among Hispanics in the United States.[31]

Assessment of IPI

All participants were followed from delivery of the index pregnancy (the end of the PBS study) through July 31, 2016 using a combination of electronic medical record (EMR) and billing data. We used the labor and delivery EMR to identify subsequent deliveries, miscarriages, and terminations after

the index pregnancy. Among subsequent deliveries, we calculated the date of pregnancy onset using the best obstetrical estimate based upon ultrasound and last menstrual period (LMP).

For miscarriages and terminations, we used the EMR to search for a positive pregnancy test (serum human chorionic gonadotropin level >5 mIU/mL). For those with a positive pregnancy test, manual record review was used to establish the best obstetrical estimate of LMP.

For women without a subsequent pregnancy, we queried the hospital billing database to find the last inpatient or outpatient visit date up to the end of follow-up (July 31, 2016). For those without a follow-up visit in the hospital system, we used the last date of contact during the index pregnancy as recorded in the PBS study.

IPI was calculated as the time from the date of delivery of the index pregnancy to the date of subsequent pregnancy onset or, in the case of miscarriages and terminations, the date of the first day of the LMP. For women without a subsequent pregnancy, follow-up time was calculated as the difference between the date of delivery of the index pregnancy to the last follow-up visit or date of contact and therefore was a continuous outcome measure. In a secondary analysis, we created a dichotomous outcome variable for short IPI, defined as an interval ≤18 months.[2] Women who were observed for <18 months and did not have a subsequent pregnancy during this time were excluded from this secondary analysis.

Covariate assessment

At the time of enrollment of participants into PBS, interviewers collected information on sociodemographic characteristics, behavioral factors, and psychosocial factors. Clinical characteristics of the index pregnancy and medical history information were abstracted from medical records. Information on alcohol consumption, cigarette smoking, and sociodemographic factors were collected using questions from the Pregnancy Risk Assessment Monitoring System.[32] Perceived stress was assessed using Cohen's Perceived Stress Scale (PSS-14).[33] Trait anxiety was assessed using the Spielberger State-Trait Anxiety Inventory (STAI)[34] with increasing numbers reflecting greater levels of stress and anxiety, respectively. We categorized perceived stress and trait anxiety as low (the bottom three quartiles) or high (the fourth quartile), respectively. Acculturation was measured *via* generation in the United States, preferred language, and the Psychological Acculturation Scale.[35]

Statistical analysis

We evaluated participant characteristics with frequencies and percentages according to level of depressive symptoms and short IPI, respectively, and assessed differences using chi square tests. We used Cox proportional hazards models to assess the unadjusted and adjusted hazard ratios (HRs) and 95% confidence intervals (CIs) between our three depressive symptom scores (continuous, at least probable minor depression, and probable major depression) and IPI as a continuous outcome variable. To evaluate the association between maternal characteristics, depressive symptom scores, and odds of short IPI, we utilized logistic regression to report unadjusted and adjusted odds ratios (aOR) and 95% CIs.

For all multivariable models, we adjusted for age, parity, body mass index (BMI), and smoking. We assessed the remaining covariates for inclusion in the models using the change in estimate approach; specifically, those covariates leading to at least a 10% change in the estimate for the depressive symptom exposures were included in the final models.[36] Using this criteria, acculturation, stress, anxiety, marital status, alcohol consumption, and sociodemographic characteristics did not meet the threshold for inclusion in models. Statistical significance was set at an alpha of 0.05.

Finally, we conducted several sensitivity analyses. First, we evaluated the impact of depressive symptoms on shorter IPIs defined as ≤12 and ≤6 months, respectively. Second, we compared characteristics of women missing the delivery date of the index pregnancy or information on depressive symptoms during pregnancy to those not missing these data. We also compared characteristics of women excluded from the short IPI analysis (*i.e.*, not followed for at least 18 months after the index pregnancy) to those not excluded from this analysis. We conducted statistical analyses using Stata v15.1 (StataCorp LP, College Station, TX).

We conducted *a priori* power calculations based upon estimates from preliminary data assuming a conservative sample size of 850 participants and projecting an exposure distribution of 20% with probable major depression and 30% with at least probable minor depression with a baseline survival probability of 65%. Using a two-sided alpha of 0.05, we calculated sufficient power (>80%) to observe HRs of 1.4 or greater between participants with and without depression. For the continuous EPDS measure, assuming a 35% event rate and a standard deviation (SD) of 6.0, we had sufficient power to detect an HR of 1.03 for every unit increase of EPDS. Finally, assuming a 20% incidence rate of short IPI, we had sufficient power to detect an odds ratio (OR) of 1.7 or greater. Power was conducted using NCSS PASS.

Results

The final analytic sample included 1262 women. Approximately 35% of participants ($n = 440$) had at least probable minor depression and 25% of participants ($n = 315$) had probable major depression at any of the three pregnancy time points in their index pregnancy. The majority of participants were young (70.6% < age 25), never married (82.3%), and receiving public insurance (93.2%). Women with either probable minor or major depression had lower education levels, were less likely to be married, and were less likely to be nulliparous than women without depression over the course of pregnancy (Table 1). In addition, both depressed groups were more likely to smoke during pregnancy and use alcohol before pregnancy. High trait anxiety and perceived stress during pregnancy were also more prevalent among women with probable minor or major depression.

Participants were followed for a median of 3.7 years (interquartile range = 1.4–6.0 years). A total of 632 (50.1%) participants had a subsequent pregnancy with an overall incidence rate of 128 per 1000 person-years (Table 2). A total of 630 participants (49.9%) did not have a subsequent pregnancy; of this group, 94.3% had a subsequent follow-up visit within the BMC system, whereas for 5.7% of women, their last date of contact was during the PBS study.

Table 1. Characteristics of the Study Population ($N = 1262$); Proyecto Buena Salud, Western Massachusetts, 2006–2011

	Total sample	*Minor depression*[a]		*Major depression*[b]	
	n *(%)*	n *(%)*	p	n *(%)*	p
Total	1262 (100)	440 (34.9)		315 (25.0)	
Maternal age (years)			0.163		0.443
16–19	393 (31.2)	126 (28.7)		88 (28.0)	
20–24	497 (39.4)	175 (39.9)		127 (40.4)	
25–29	224 (17.8)	91 (20.7)		63 (20.1)	
≥30	146 (11.6)	47 (10.7)		36 (11.5)	
Education			0.007		0.001
Less than high school	583 (48.8)	229 (54.4)		173 (57.7)	
High school graduate or GED	387 (32.4)	129 (30.6)		86 (28.7)	
Post high school	225 (18.8)	63 (15.0)		41 (13.7)	
Marital status			0.024		0.015
Never married	988 (82.3)	351 (84.6)		248 (83.8)	
Married	135 (11.2)	33 (8.0)		22 (7.4)	
Other (separated/divorced/widowed)	78 (6.5)	31 (7.5)		26 (8.8)	
Public insurance			0.006		0.008
No	85 (6.8)	18 (4.1)		11 (3.5)	
Yes	1174 (93.2)	422 (95.9)		304 (96.5)	
Prepregnancy BMI (kg/m^2)			0.097		0.116
<18.5	79 (6.3)	30 (6.9)		23 (7.3)	
18.5 to <25	600 (47.9)	220 (50.3)		161 (51.4)	
25 to <30	292 (23.3)	84 (19.2)		58 (18.5)	
≥30	282 (22.5)	103 (23.6)		71 (22.7)	
Parity			0.032		0.160
0 Live births	523 (41.5)	162 (37.0)		116 (37.1)	
1 Live birth	384 (30.5)	137 (31.3)		100 (31.9)	
≥2 Live births	352 (28.0)	139 (31.7)		97 (31.0)	
Preferred language			0.108		0.553
English	962 (76.2)	347 (78.9)		244 (77.5)	
Spanish	300 (23.8)	93 (21.1)		71 (22.5)	
Acculturation level[c]			0.959		0.426
Low	898 (79.2)	318 (79.1)		232 (80.8)	
High	236 (20.8)	84 (20.9)		55 (19.2)	
Generation in United States			0.192		0.100
Born in PR/DR	572 (46.8)	189 (44.3)		133 (43.5)	
Parent born in PR/DR	579 (47.4)	217 (50.8)		160 (52.3)	
Grandparent born in PR/DR	70 (5.7)	21 (4.9)		13 (4.2)	
Smoking during index pregnancy			<0.001		<0.001
Never	791 (65.6)	243 (56.9)		161 (52.6)	
Former	210 (17.4)	70 (16.4)		53 (17.3)	
Current (ever during pregnancy)	205 (17.0)	114 (26.7)		92 (30.1)	
Prepregnancy alcohol use			0.002		0.001
None	720 (60.2)	241 (57.2)		172 (57.1)	
0 to <5 Drinks/month	208 (17.4)	63 (15.0)		44 (14.6)	
5 to 12 Drinks/month	126 (10.5)	48 (11.4)		30 (10.0)	
≥12 Drinks/month	142 (11.9)	69 (16.4)		55 (18.3)	
High trait anxiety[d]			<0.001		<0.001
No	872 (76.1)	180 (43.8)		104 (35.6)	
Yes	274 (23.9)	231 (56.2)		188 (64.4)	
High perceived stress[e]			<0.001		<0.001
No	964 (76.8)	206 (46.9)		118 (37.5)	
Yes	292 (23.2)	233 (53.1)		197 (62.5)	

Numbers may not sum to 1262 due to missing data.
[a]EPDS score ≥13 indicates at least probable minor depression.
[b]EPDS score ≥15 indicates probable major depression.
[c]Psychological Acculturation Scale score: low = 1–2, high = 3–5.
[d]Spielberger Trait Scale Anxiety score: high (fourth quartile) >48.
[e]Cohen's Perceived Stress Scale (PSS-14): high (fourth quartile) >32.
BMI, body mass index; EPDS, Edinburgh Postnatal Depression Scale; PR/DR, Puerto Rico/Dominican Republic.

Table 2. Unadjusted and Multivariable Hazard Ratios and 95% Confidence Intervals of Depression and Interpregnancy Interval: Proyecto Buena Salud, 2006–2011

	Median time to subsequent pregnancy (95% CI)	*Sample*	*Subsequent pregnancies*	*Person-years*	*IR*	*Unadjusted model*		*Adjusted model*[a]	
						HR	*95% CI*	*HR*	*95% CI*
Depressive symptom score[b]	5.1 (4.7–5.8)	1262	632	4939	128	1.01	0.99–1.02	1.00	0.99–1.02
At least probable minor depression[c]									
No	5.4 (4.7–6.1)	822	404	3230	125	1.00	Referent	1.00	Referent
Yes	4.8 (4.0–5.8)	440	228	1709	133	1.09	0.93–1.28	1.09	0.92–1.29
Probable major depression[d]									
No	5.3 (4.7–6.0)	947	464	3717	125	1.00	Referent	1.00	Referent
Yes	4.7 (3.6–5.8)	315	168	1221	137	1.12	0.94–1.34	1.12	0.93–1.34

[a]Adjusted for age category, parity, BMI category, and smoking.
[b]Continuous EPDS score.
[c]EPDS score ≥13 indicates at least probable minor depression.
[d]EPDS score ≥15 indicates probable major depression.
CI, confidence interval; HR, hazard ratio; IR, incidence rate per 1000 person-years; PY, person-years.

We first evaluated the association between depressive symptom scores and IPI as a continuous outcome variable (Table 2). In unadjusted analyses, the continuous depressive symptom score (HR = 1.01; 95% CI = 0.99–1.02) was not statistically significantly associated with IPI. Similarly, having at least probable minor depression (HR = 1.09; 95% CI = 0.93–1.28) or probable major depression (HR = 1.12; 95% CI = 0.94–1.34) during the index pregnancy was not significantly associated with IPI. Adjustment for age, parity, BMI category, and smoking did not substantively change these findings.

We then evaluated the association between maternal characteristics and short IPI (≤18 months) (Table 3). For this secondary analysis, we additionally excluded 98 (8%) women who were not observed for at least 18 months and did not have a subsequent pregnancy during that time. Therefore the sample for this secondary analysis included 1164 participants. A total of 240 (20.6%) participants experienced a short IPI. In unadjusted analyses, women who were underweight (OR = 2.12, 95% CI = 1.24–3.60) or obese (OR = 1.57, 95% CI = 1.11–2.23) had increased odds of short IPI as compared with normal weight women. Odds of short IPI were reduced for older women (OR = 0.51, 95% CI = 0.29–0.89 for ≥30 years of age vs. 16–19 years), for women with higher degrees of education (OR = 0.59, 95% CI = 0.38–0.92 for post-high school vs. less than high school), for women who were separated/divorced/widowed (OR = 0.45, 95% CI = 0.21–0.95 vs. never married), and increased for women on public versus private insurance (OR = 2.53, 95% CI = 1.14–5.59) and for women with high levels of perceived stress (OR = 1.44, 95% CI = 1.05–1.99 vs. low levels).

We then evaluated the association between depressive symptoms and short IPI. After adjusting for age, parity, BMI category, and smoking, we did not observe a statistically significant association between the continuous depressive symptom score (aOR = 1.01, 95% CI = 0.98–1.04) and odds of short IPI (Table 4). However, women with at least probable minor depression (aOR = 1.39, 95% CI = 1.02–1.88) and probable major depression (aOR = 1.42, 95% CI = 1.02–1.97) during pregnancy had increased odds of short IPI.

We then conducted several sensitivity analyses. First, we evaluated the impact of depressive symptoms on shorter IPIs defined as ≤12 and ≤6 months, respectively. Findings for IPI defined as ≤12 months ($n = 162$, 14.9%) were comparable with our primary analyses. When we defined short IPI as ≤6 months (number of cases = 63, 5.4%), odds ratios were strengthened for women with at least probable minor depression (aOR = 1.98, 95% CI = 1.17–3.36) and probable major depression (aOR = 1.92, 95% CI = 1.10–3.35).

In our second sensitivity analysis, women missing the delivery date of the index pregnancy did not differ from women not missing this information in terms of depressive symptoms nor other behavioral and medical history factors; however, they were more likely to have higher levels of education. Similarly, women missing information on depressive symptoms during pregnancy did not differ from women not missing this information in terms of any of the above factors aside from being less likely to have public insurance. Women excluded from the short IPI analysis did not differ from women not missing this information in terms of depression and the majority of other behavioral and medical history covariates, but were more likely to be older, be a current smoker, have greater levels of education and acculturation, and were less likely to have public insurance than women not excluded from this analysis.

Discussion

In this prospective cohort study evaluating the association between prenatal depressive symptoms and IPI among a predominantly Puerto Rican population in Western Massachusetts, depressive symptoms were common with 25% of participants reporting probable major depression. Although we did not observe a statistically significant association between depressive symptoms in pregnancy and IPI overall, we found that women with at least probable minor depression and probable major depression had a modest increase in odds of short IPI after adjusting for age, parity, BMI category, and smoking.

Our findings between depressive symptoms and IPI are consistent with the majority of previous studies that were largely limited to adolescent populations. In one of the few previous studies among adult women, Bennett et al. evaluated the association between postpartum depressive symptoms and

Table 3. Correlates of Short Interpregnancy Interval: Proyecto Buena Salud, Western Massachusetts, 2006–2011

	Short interpregnancy interval		
	No (n = 924), n (%)	*Yes (n = 240), n (%)*	*Odds ratio (95% CI)*
Maternal age (years)			
16–19	285 (30.9)	84 (35.0)	Referent
20–24	360 (39.0)	105 (43.8)	0.99 (0.71–1.37)
25–29	163 (17.7)	34 (14.2)	0.71 (0.45–1.10)
≥30	114 (12.4)	17 (7.1)	0.51 (0.29–0.89)
Education			
Less than high school	419 (48.0)	123 (54.2)	Referent
High school graduate or GED	286 (32.8)	75 (33.0)	0.89 (0.65–1.24)
Post high school	168 (19.2)	29 (12.8)	0.59 (0.38–0.92)
Marital status			
Never married	716 (82.0)	199 (85.8)	Referent
Married	93 (10.7)	25 (10.8)	0.97 (0.61–1.55)
Separated/divorced/widowed	64 (7.3)	8 (3.4)	0.45 (0.21–0.95)
Public Insurance			
No	65 (7.1)	7 (2.9)	Referent
Yes	856 (92.9)	233 (97.1)	2.53 (1.14–5.59)
Prepregnancy BMI (kg/m^2)			
<18.5	50 (5.5)	24 (10.0)	2.12 (1.24–3.60)
18.5 to <25	454 (49.5)	103 (42.9)	Referent
25 to <30	217 (23.7)	43 (17.9)	0.87 (0.59–1.29)
≥30	196 (21.4)	70 (29.2)	1.57 (1.11–2.23)
Parity			
0 Live births	374 (40.5)	114 (47.9)	Referent
1 Live birth	290 (31.4)	66 (27.7)	0.75 (0.53–1.05)
≥2 Live births	259 (28.1)	58 (24.4)	0.73 (0.52–1.05)
Preferred language			
English	699 (75.6)	192 (80.0)	1.29 (0.91–1.83)
Spanish	225 (24.4)	48 (20.0)	Referent
Acculturation level			
Low	669 (80.8)	166 (77.2)	Referent
High	159 (19.2)	49 (22.8)	1.24 (0.86–1.78)
Generation in United States			
Born in PR/DR	419 (46.9)	109 (46.6)	Referent
Parent born in PR/DR	429 (48.0)	106 (45.3)	0.95 (0.70–1.28)
Grandparent born in PR/DR	45 (5.0)	19 (8.1)	1.62 (0.91–2.89)
Smoking during index pregnancy			
Never	569 (64.7)	163 (70.3)	Referent
Former	168 (19.1)	29 (12.5)	0.60 (0.39–0.93)
Current (ever during pregnancy)	142 (16.2)	40 (17.2)	0.98 (0.66–1.45)
Prepregnancy alcohol use			
None	517 (59.0)	143 (63.0)	Referent
0 to ≤5 Drinks/month	158 (18.0)	39 (17.2)	0.89 (0.60–1.33)
5 to ≤12 Drinks/month	90 (10.3)	24 (10.6)	0.96 (0.59–1.57)
>12 Drinks/month	111 (12.7)	21 (9.3)	0.68 (0.41–1.13)
High trait anxiety			
No	648 (77.3)	160 (73.4)	Referent
Yes	190 (22.7)	58 (26.6)	1.24 (0.88–1.74)
High perceived stress			
No	721 (78.2)	169 (71.3)	Referent
Yes	201 (21.8)	68 (28.7)	1.44 (1.05–1.99)

unintended repeat pregnancy by the end of the first postpartum year among 643 low-income inner-city women.[17] The authors did not observe a significant association between elevated postpartum depressive symptoms (>16 on the Center for Epidemiologic Studies Depression Scale [CES-D]) and subsequent unintended pregnancy (aOR = 1.08, 95% CI = 0.56–2.08).

Other studies of IPI and mental health conducted in adolescents often did not adjust for covariates, or were attenuated and no longer statistically significant after adjustment.

Table 4. Unadjusted and Multivariable Odds Ratios and 95% Confidence Intervals of Depression and Short Interpregnancy Interval: Proyecto Buena Salud, 2006–2011

		Short interpregnancy interval					
		Subsequent pregnancies		*Unadjusted model*		*Adjusted model*[a]	
	Sample	n	*%*	*OR*	*95% CI*	*OR*	*95% CI*
Depressive symptom score[b]	1164	240	20.6	1.01	0.99–1.04	1.01	0.98–1.04
At least probable minor depression[c]							
No	763	143	18.7	1.00	Referent	1.00	Referent
Yes	401	97	24.2	1.38	1.03–1.85	1.39	1.02–1.88
Probable major depression[d]							
No	874	168	19.2	1.00	Referent	1.00	Referent
Yes	290	72	24.8	1.39	1.01–1.90	1.42	1.02–1.97

[a]Adjusted for age category, parity, BMI category and smoking.
[b]Continuous EPDS score.
[c]EPDS score ≥13 indicates at least probable minor depression.
[d]EPDS score ≥15 indicates probable major depression.
OR, odds ratio.

For example, Patchen et al. evaluated the association between maternal mental health and short IPI among 139 diverse adolescents (59% African American, one-third Spanish speaking) who were part of the Teen Alliance for Prepared Parenting at Washington, DC.[16] Indicators of poor mental health and trauma were abstracted from social work case notes and coded using the Beck Depression Inventory. In descriptive analyses, adolescents with short IPI (<24 months) had a significantly higher number of indicators of poor prenatal mental health and trauma (mean ± SD = 3.97 ± 3.79 vs. 2.14 ± 1.75, $p = 0.002$) than those without short IPI; however, adjusted analyses were not conducted. Similarly, in a study of 354 predominantly African American adolescents, Crittenden et al. found that depression (measured using the RAND Mental Health Inventory) was associated with short IPI (<24 months) in unadjusted (Wald $\chi^2 = 3.68$, $p = 0.05$), but not adjusted analyses.[20] These findings indicate that other factors, in addition to depression, may be important predictors of short IPI.

The strengths of our study include use of data from a large prospective cohort. It is the first, to our knowledge, to evaluate the association between depression and IPI among Latinas. A further strength is the use of the EPDS, designed to measure depression in the pregnancy and postpartum time periods. In contrast, the majority of previous studies used depression scales, such as the CES-D, which were created for use in the general population and include somatic symptoms of depression that are also common symptoms of pregnancy (*e.g.*, fatigue). Therefore, their use could lead to an overestimate of elevated depressive symptom rates unlike the EPDS, which was specifically developed to account for these commonalities.[37]

The majority of previous studies followed women for relatively short follow-up periods. In contrast, women in our study were followed for a median of 3.7 years. In addition, those studies that focused only on unintended pregnancy[17,21] differ in important ways from our outcome of IPI. Specifically, unintended pregnancy does not account for pregnancies that were intended, that failed, or were terminated before the time of interview.

This study is also subject to several limitations. Although a score of 15 or higher on the EPDS does not confirm depression, the EPDS is widely used to indicate probable depressive disorder and has been demonstrated to have good sensitivity and specificity when validated using a structured clinical interview to diagnose depression.[28] It allows for the systematic assessment of depression and reduces the misclassification that would occur if clinical records were used, as depression during pregnancy is often underdiagnosed and undertreated.[38] Brief screening instruments, such as the EPDS, have practical clinical utility in that they identify a high-risk group who may benefit from intervention.

Although the EPDS was administered in early, mid, and late pregnancy, we averaged depression information over the course of pregnancy as our sample size precluded the evaluation of trimester-specific effects. However, minimizing this concern is the observation that depressive symptoms were relatively stable over pregnancy in the study population.[39] Using the average scores also reduces the impact of a missing assessment at an individual time point.

Another limitation is the lack of information on history of depression, which may confound the relationship between prenatal depressive symptoms and IPI. However, this concern is minimized as we would anticipate that a large portion of women with depression before pregnancy would also report depression during pregnancy. Indeed, depression relapse rates are particularly high during pregnancy.[40] Similarly, prenatal depression, correlates highly with postpartum depression.[39] In addition, we did not have information on adequacy of prenatal care. However, data for Massachusetts in 2016 indicate that almost 90% of live births were to women receiving adequate, adequate plus, or intermediate prenatal care. Only one-tenth of live births were to women receiving inadequate care defined as care beginning in the fifth month or later or <50% of the appropriate number of visits for the infant's gestational age.[41] To the extent that this factor was associated with depressive symptoms during pregnancy, this may have confounded our findings.

We did not have information on postpartum factors such as attendance at the postpartum check-up, postpartum contraceptive use, postpartum depression, treatment for postpartum depression, pregnancy intention, or breastfeeding, all of which could be on the causal pathway between depression during pregnancy and short IPI. However, in Massachusetts in 2011, 90.7% of Hispanic mothers had a postpartum

checkup and 83.4% of Hispanic mothers reported using contraception after their most recent birth.[42] In terms of treatment for postpartum depression, standard clinic practice for patients who screen positive for depression is to inform their clinician and to provide them with referrals to mental health resources.

Regardless of the pathway however, findings that prenatal depression were a risk factor for short IPI would underscore the importance of screening for depression during pregnancy to target women at risk. Future studies should be designed to *a priori* evaluate the pathways by which depression impacts subsequent IPI.

Results from our sensitivity analysis indicated that participants missing information on delivery date or depression, or who were not observed for at least 18 months, were largely similar with regard to sociodemographic characteristics, behavioral factors, and psychosocial factors to those not missing these data. However, they had higher education, age, parity, and were more likely to be married. To the extent that these factors were associated with depression and short IPI, this could have confounded our findings. It is unlikely, however, that a large proportion of women not observed for at least 18 months delivered elsewhere, as BMC is the only tertiary care provider in Western Massachusetts and the only hospital with a level 3 neonatal intensive care unit. The Baystate Health catchment area consists of both inner city urban and rural hill town environments, and operates hospitals, clinics, and physician practices that serve both populations. Although data are not available on residential movement completely out of the catchment area, because of the lower levels of income and education faced by this population, this likelihood appears low.

Based upon a conservative sample size of 850, we had *a priori* calculated that we had power to detect HRs of 1.4 or greater for IPI and odds ratios of 1.7 or greater for short IPI. For the continuous EPDS measure, we had power to detect an HR of 1.03 for every unit increase. With our larger sample size of 1262 we had power to detect somewhat smaller associations. In a sensitivity analysis, we observed a stronger increased odds of short IPI when defined as ≤6 months for at least probable minor and probable major depression, respectively. This finding suggests that the postpregnancy effect of depression on IPI might be more accurately predicted by prenatal depression for short intervals after pregnancy. In contrast, as the interval increases, pregnancy intention may become a more important predictor, thereby diluting the potential impact of depression through a pathway of unintended pregnancy.[10,11] However, we also note that the odds ratio is a relative measure, and when the baseline risk is lower among the reference group (*i.e.*, those without depressive symptoms) as it is for an IPI of ≤6 months, the odds ratio can appear stronger despite a similar absolute difference in risk. Therefore these findings suggest the need for further evaluation of the role of depression in IPI.

To be consistent with the U.S. census, PBS enrolled women of ''Caribbean Island'' descent, which included both Puerto Ricans and Dominicans.[24] Although our study did not distinguish between these two Hispanic subgroups, U.S. census data indicate that 93.2% of citizens of Caribbean heritage in Springfield, Massachusetts are of Puerto Rican origin.[43] Because our study population was restricted to predominantly unmarried women of Puerto Rican and Dominican heritage (Caribbean Islanders) who were receiving public insurance, caution should be taken in generalizing findings to other groups. Finally, it is also important to note the issue of direction of association. Specifically, in addition to evaluating depression as a potential modifiable risk factor for short IPI, short IPI may also be a risk factor for subsequent maternal depression.[44] Our goal in this study was to evaluate the former association, but future studies should also address the latter.

In summary, in this predominantly Puerto Rican population, we found that depressive symptoms, assessed in early, mid, and late in pregnancy, were a modest risk factor for short IPI. The identification of new modifiable risk factors for short IPI, such as depression, remains important to reduce adverse pregnancy outcomes. Future research should examine the multiple pathways through which mental health may affect IPIs in vulnerable populations.

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