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Interleukin-10 Predicts Preterm Birth in Acculturated Hispanics

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Abstract

Objective—In Hispanics living in the U.S., acculturation is associated with increased risk for preterm birth. Inflammatory pathways are also associated with preterm birth. As such, the current study sought to investigate the potential relationships among preterm birth, acculturation of Hispanic women, and inflammatory markers.

Study Design—We performed an observational study on pregnant Hispanic women in Texas at 22–24 weeks' gestation ($n = 470$). We obtained demographic data prenatally as well as birth outcome data from the medical chart after delivery. We obtained venous blood and used plasma to assay interleukin-1 receptor antagonist (IL-1RA), IL-6, and IL-10. We used logistic regression to understand if the presence or absence of IL-10 levels were related to acculturation and the risk of preterm birth.

Results—We observed interactions between undetectable IL-10 levels and years in the U.S. and undetectable IL-10 levels and being born in the U.S. in models predicting preterm birth. Follow-up probes of these interactions suggested that when IL-10 was undetectable, preterm birth became more likely as time living in the U.S. increased ($\chi^2 = 5.15$ (1, 416), $p = .020$, OR = 3.17) and was more likely in participants born in the U.S. than in those born elsewhere ($\chi^2 = 5.35$ (1, 462), $p = .020$, OR = 16.78). We observed no interactions among acculturation, preterm birth, and IL-1RA and IL-6 levels.

Conclusion—Acculturated Hispanics who lack the protective effects of IL-10 experience a markedly higher risk of preterm birth than non-acculturated Hispanics.

Keywords

Cytokines; Inflammation; Interleukins; Pregnancy; Acculturation

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Preterm birth is a major cause of infant mortality and numerous long-term health conditions such as neurocognitive and pulmonary morbidities (Martin et al., 2007). In the United States, preterm birth occurs in 12% of live births (March of Dimes, 2010). Alarming, the overall rate of preterm birth has increased by approximately 30% over the last 3 decades (Martin et al., 2007).

Preterm birth rates vary greatly among ethnicities. Environmental and behavioral disparities may also influence preterm birth rates (Institute of Medicine, 2007). For example, the rate of preterm birth in Hispanics in the United States is highly influenced by acculturation through exposure to and adoption of U.S. behaviors and cultural beliefs (Cabassa, 2003). Hispanic women of lower socioeconomic status have better health outcomes than non-Hispanic Whites with comparable socioeconomic status. Paradoxically, preterm birth rates increase in Hispanics with greater levels of acculturation. A current theory suggests that individuals who are acquiring these new behaviors or cultural beliefs show an increased risk for preterm birth (Zambrana, Scrimshaw, Collins, & Dunkel-Schetter, 1997). Additional evidence suggests that, compared to foreign-born Hispanics, U.S.-born Hispanics show greater signs of “weathering,” a rapid decline in reproductive health (Wildsmith, 2002). As the Hispanic population is a rapidly expanding segment of the U.S. population, the increases in preterm birth in acculturated Hispanics is a potentially serious and growing burden on the U.S. healthcare system.

Empirical evidence suggests that preterm birth is a multifactorial phenomenon involving deleterious and protective factors (Challis et al., 2009; Lyon et al., 2010). In the case of Hispanics in the United States, acculturation increases their risk of preterm birth by decreasing the protective influence of progesterone (Ruiz et al., 2008). These findings have raised the question of whether the relationship between acculturation and preterm birth is mediated by additional biological pathways such as inflammation.

Inflammation plays a prominent role in the length of gestation (Challis et al., 2009; Lyon et al., 2010). During pregnancy, the balance between the pro-inflammatory Th1 cytokines and the anti-inflammatory Th2 cytokines undergoes a shift resulting in a predominance of Th2-derived signaling pathways. This increased activity of Th2 cytokines coupled with decreased activity of Th1 cytokines is thought to provide a protective influence on the materno-fetal interface and to facilitate normal, healthy gestation. The effects of Th1 and Th2 pathways during pregnancy are differentially mediated through specific signaling molecules. For example, interleukin-10 (IL-10) is a specific Th2 cytokine that serves as a protective factor for preterm birth (Challis et al., 2009; Lyon et al., 2010). Investigators believe that the protective effects of IL-10 are similar to the effects of progesterone (Chaouat, Meliani, & Martal, 1995; Piccinni et al., 1995). In contrast, IL-1 and IL-6 are specific Th1 cytokines associated with an increased risk of preterm birth (Challis et al., 2009; Lyon et al., 2010). The purpose of the current study was to investigate the potential relationships among acculturation, preterm birth, the anti-inflammatory Th-2 cytokine IL-10, and the pro-inflammatory Th1 cytokines IL-1 and IL-6 (Figure 1).

Methods

Participants

We used a cross-sectional design at 22–24 weeks’ gestational age. A power analysis of the sample ($n = 470$) estimated a power of 0.80 with the ability to detect moderate statistical effects with $p < .05$. We used a number of criteria to select participants, including singleton intrauterine pregnancy at 22–24 weeks confirmed by ultrasound and date of last menstruation, self-reported Hispanic ethnicity, ability to read Spanish or English, and age between 14 and 40 years. Participants were excluded from the study based on the following

criteria: identified cervical or intrauterine abnormalities, inability to read Spanish or English, kidney disease, multiple gestation, immune disorders, heart disease, asthma, diabetes, hypertension, identified pre-eclampsia, oral steroid use within 1 month of data collection, congenital fetal abnormalities revealed by ultrasound, active placenta previa or cervico-vaginal bleeding, blood group isoimmunization, diagnosis of major mental disorders, or self-identification of non-Hispanic ethnicity. We did include patients in the study if they had diet control for gestational diabetes or if they were diagnosed with pre-eclampsia after data collection. The study was approved by the Institutional Review Boards at The University of Texas Health Science Center in San Antonio and The University of Texas Medical Branch in Galveston. All participants gave informed consent in Spanish or English.

Data collection took place between 2003 and 2007 at several locations in Texas. Patients from the Houston/Gulf Coast area ($n = 60$) were selected from a single community clinic in Pasadena, TX, served primarily by advanced practice nurses. The majority of these patients were self-pay or state funded. Patients from the San Antonio/South Texas area were selected from five private-practice physicians ($n = 158$) and were primarily Medicaid. In the Austin/Central Texas area, patients were selected from five Austin community clinics ($n = 252$) served mainly by advanced practice nurses and were primarily self-pay or state funded. Patients began prenatal care at an average of 9 weeks gestation, with 83.1% of participants beginning care before 12 weeks.

Procedures

We reviewed prenatal records of potential participants to determine pregnancies at less than 22 weeks' gestational age. Once we identified gestational age, we recruited patients either just before or just after routine prenatal clinic visits. The recruiter meticulously described the risks and benefits of the study to the participants and scheduled data collection at a separate time from the prenatal clinic visit.

At the time of data collection, the research nurse obtained demographic data from the patients' charts. We also asked participants to provide a detailed chart of family origin including their country of birth and those of their parents and grandparents. The research nurse calculated the body mass index (BMI) using the patients' pre-pregnancy height and weight obtained from the charts. The research nurse also drew a venous blood sample, performed a speculum examination, collected urine, and collected vaginal discharge on a microscope slide for later determination of bacterial vaginosis (BV) by a gram staining (Nugent, Krohn, & Hillier, 1991) procedure previously described in this lab. Urine samples were later processed to determine if cotinine and or illicit drugs were present. All appointments with the patients were conducted between 12 and 2pm to control for any diurnal variations in plasma cytokine levels.

Assessment of Preterm Birth

After birth, maternal and infant outcomes were acquired through the review of patients' charts. An ultrasound at less than 20 weeks was used as the preferred dating criteria to establish gestational age at birth. If an ultrasound at less than 20 weeks was not available, we used a combination of gestational age by exam and last menstrual period to establish gestational age. Preterm birth was defined by parturition before 37 weeks 0 days' gestational age.

Acculturation Measures

We used several variables to approximate acculturation including English proficiency, country of birth (foreign or U.S. born) and years spent in the United States. English proficiency was assessed with a self-report instrument, the Bidimensional Acculturation

Scale for Hispanics, with an applied a cutoff score of 2.5 to indicate a high or low level of English proficiency (Marin & Gamba, 1996). Investigators have used these standard measures of acculturation in numerous health-based studies (Abraído-Lanza, Chao, & Flórez, 2005), and they show high levels of validity, correlating strongly with other measures of acculturation including multidimensional scales and language-based measures (Marin & Marin, 1991).

Cytokine Analysis

After collection, venous blood samples were immediately centrifuged at 2000 rpm for 10 min. The plasma supernatant was then decanted and stored in polypropylene tubes at -80°C . IL-1 receptor antagonist (IL-1RA), IL-6, and IL-10 levels were determined with highly sensitive enzyme linked immunosorbent assay (ELISA) kits purchased from R&D Systems, Inc. (Minneapolis, MN). IL-1RA is an endogenous cytokine that counters the actions of IL-1 and thus is often used as an indirect measure of IL-1 activity (Arend, 2002). The minimal detectable dose was < 22 pg/ml for IL-1RA, < 0.070 pg/ml for IL-6, and < 3.9 pg/ml for IL-10. Assay results were read spectrophotometrically using a μ -Quant Reader (Bio-Tek Instruments, Inc., Winooski, VT). The same laboratory technician performed all assays and was blind to participant names and information. Inter- and intra-assay variance was less than 15% for each analyte.

Statistical Analysis

We examined the distributional properties of each of the cytokines prior to analysis to determine the optimal method for modeling each measure. Distributions of IL-1RA and IL-6 were characterized by positive skew. We performed a natural log transformation to these variables to avoid disproportionate influence of extreme values and to aid in the interpretation of the models. Distributions for both variables appeared approximately normal after the transformation. We additionally transformed these variables to z scores so that odds ratios could be interpreted in terms of change in odds per standard deviation. The IL-10 distribution was characterized by a large number of zero values (22.1%) and a right-skewed distribution for nonzero values. Because the most salient characteristic of the distribution was the presence or absence of IL-10, we decided to model IL-10 as a binary variable where 1 represents detectable levels of IL-10 and 0 represents nondetectable levels of IL-10. We converted the continuous measure *years in the U.S.* to z scores for modeling to facilitate the interpretation of the odds ratio.

We performed data analysis using SAS statistical software (version 9.2). We computed descriptive statistics for demographic and biological measures. Next, we implemented logistic regression models and follow-up contrasts using SAS PROC GLIMMIX. We constructed logistic regression models to examine rates of preterm birth as a function of each of the cytokines, acculturation measures, and the interaction between IL-10 and acculturation measures. To avoid redundancy, we analyzed each of the cytokines with two acculturation measures (*years in the United States* and *born in the United States*), resulting in six models. In each model, preterm birth was regressed on a cytokine, an acculturation variable, the interaction between the cytokine and the acculturation variable, and a number of demographic and biological covariates. We hypothesized significant interactions, and in the event of such interactions we performed follow-up contrasts that compared cytokine levels within levels of the acculturation measures. For the *years in the United States* measure, models estimated the predicted probability of preterm birth for detectable and undetectable levels of cytokines at points below and above the mean. For the dichotomous measure, *born in the United States*, we conducted the same contrast between detectable and undetectable levels of cytokine within participants born in the United States. and those not born in the United States.

Results

Sample Characteristics

The sample characteristics, including demographics, inflammatory markers, and birth outcomes, are presented in Table 1. Importantly, the data reveal similar rates of preterm birth for women with similar levels of acculturation across acculturation measures. Approximately 10% of women who were born in the United States or had lived in the United States for more than 10 years had preterm births, while approximately 5% of participants that were foreign born or had been in the United States for less than 10 years had preterm births. We found similar rates for women with high English proficiency versus those with low English proficiency, respectively. In addition, participants with high English proficiency had higher levels of IL-1RA than those with low proficiency. We split the *years in the United States* variable due to a bimodal distribution. Relatively half of the sample reported the United States as their place of birth and had resided in the United States for more than 10 years, while the other half of the sample had been in the United States for less than 10 years.

Demographic and Biological Characteristics

We examined each of the demographic and biological characteristics individually as predictors of preterm birth in logistic regression models. Preterm birth was regressed on a putative demographic or biological characteristic. The intent of this analysis was to provide the most conservative estimate of the effects of each of these variables on our outcome of primary interest, as their unique effects could potentially be obscured in a multiple predictor model. Among the covariates that we included in our final model, only *history of preterm birth* was a significant predictor of preterm birth ($\chi^2 = 4.79$ [1, 468], $p = .029$, OR = 2.91).

We examined missing-data patterns prior to analysis. Among the 470 cases with an outcome for preterm birth, 4 were missing data on IL-10 or country of birth, leaving 466 participants with complete data on the variables of primary interest. We elected not to impute values for missing data as the variables in the analysis were demographic and biological and there were insufficient data to impute missing values for these variables. To assess any potential bias due to the excluded cases, we conducted analyses without covariates, allowing us to make use of all of the eligible cases. Due to the rarity of positive cotinine ($n = 3$) samples in this study, we did not include cigarette smoking in our analyses. In addition, we found that 1 mother was using an opiate drug. However, because she delivered at term, it is unlikely that drug use affected birth outcomes in this study.

Years in the United States—In the IL-1RA model, there was no main effect for *years in the United States* ($\chi^2 = 2.17$, $p = .141$, OR = 1.41), IL-1 ($\chi^2 = 0.17$ [1], $p = .175$, OR = 1.11), or the interaction between *years in the United States* and IL-1 ($\chi^2 = 1.33$ [1], $p = .249$, OR = 1.45). In the IL-6 model, there was no main effect for *years in the United States* ($\chi^2 = 3.68$ (1), $p = .055$, OR = 1.515), IL-6 ($\chi^2 = 2.74$ [1], $p = .098$, OR = 1.42), or the interaction between *years in the United States* and IL-6 ($\chi^2 = 0.551$ [1], $p = .458$, OR = 1.17). There was a significant interaction between IL-10 and *years in the United States*. We present the results for this model in Table 2. *Years in the United States* was not a significant predictor of preterm birth, but the interaction between *years in the United States* and IL-10 levels significantly predicted preterm birth. We conducted follow-up contrasts of IL-10 at 1.5 standard deviations below the mean number of years in the United States and found that there was not a significant difference between detectable and nondetectable levels of IL-10 ($\chi^2 = 2.51$ [1], $p = .113$, OR = .13). The follow-up contrasts of IL-10 at 1.5 standard deviations above the mean years in the United States indicated that there was a significant difference between detectable and nondetectable levels of IL-10 ($\chi^2 = 5.00$ [1, 416], $p = .$

025, OR = 4.10; Figure 2). We conducted analyses without covariates to confirm that results were stable when using all available data. Results were similar to those presented in the full model for *years in the United States* ($\chi^2 = 7.53$ [1,462], $p = .006$, OR = 2.95) and the interaction between detectable IL-10 and *years in the United States* ($\chi^2 = 5.48$ [1, 462], $p = .019$, OR = .351). Follow-up contrasts were also similar for comparisons of IL-10 at 1.5 standard deviations below the mean *years in the United States* ($\chi^2 = 3.06$ [1,462], $p = .081$, OR = .13) and contrasts of IL-10 at 1.5 standard deviations above the mean *years in the United States* ($\chi^2 = 3.83$ [1, 462], $p = .050$, OR = 3.02).

Born in the United States—In the IL-1RA model, there was no main effect for *born in the United States* ($\chi^2 = 0.37$ [1], $p = .541$, OR = 1.147), IL-1 ($\chi^2 = 0.143$ [1], $p = .705$, OR = 0.93), or the interaction between *years in the United States* and IL-1 ($\chi^2 = 1.25$ [1], $p = .264$, OR = 3.006). In the IL-6 model, there was no main effect for *born in the United States* ($\chi^2 = 2.956$ [1], $p = .086$, OR = 2.24), IL-6 ($\chi^2 = 0.978$ [1], $p = .323$, OR = 1.31), or the interaction between *born in the United States* and IL-6 ($\chi^2 = 0.477$ [1], $p = .490$, OR = 1.34). We present the results for *born in the United States* in Table 3. *Born in the United States* was not a significant predictor of preterm birth, but the interaction between *born in the United States* and IL-10 levels significantly predicted preterm birth. The follow-up contrasts of IL-10 among participants not born in the United States indicated that there was not a significant difference between detectable and nondetectable levels of IL-10 ($\chi^2 = 1.58$ [1, 416], $p = .209$, OR = .27). The follow-up contrasts of IL-10 among those born in the United States indicated that there was a significant difference between detectable and nondetectable levels of IL-10 ($\chi^2 = 5.78$ [1, 416], $p = .016$, OR = 4.48; Figure 3).

We conducted analyses without covariates to confirm that results were stable when using all available data. Results were similar to those presented in the full model for *born in the United States* ($\chi^2 = 6.60$ [1,462], $p = .010$, OR = 16.59) and the interaction between detectable IL-10 and born in the U.S. ($\chi^2 = 5.49$ [1, 462], $p = .019$, OR = .063). Follow-up contrasts were also similar for comparisons of IL-10 at 1.5 standard deviations below the mean *born in the United States* ($\chi^2 = 1.58$ [1,462], $p = .028$, OR = .27) and contrasts of IL-10 at 1.5 standard deviations above the mean *born in the United States* ($\chi^2 = 5.78$ [1, 462], $p = .016$, OR = 4.48).

Study Limitations

This study had several limitations. The use of country of birth and years spent in the United States as proximal variables to assess acculturation, albeit useful in the current study, does not fully characterize the complexity of acculturation. Multidimensional measures of acculturation that account for both adoption of U.S. cultural traits and conservation of Mexican cultural traits could have provided a richer, more complete estimation of acculturation. Moreover, the use of multidimensional acculturation measures could have allowed for a better understanding of putative factors linking preterm birth and acculturation such as pregnancy weight gain, illicit drug use, and tobacco use. Future studies should include multiple measures of acculturation to fully assess the complexity of the psychosocial phenomenon.

Discussion

In this study, low or absent IL-10 levels became increasingly predictive of preterm birth for those women who had lived in the United States for longer periods of time. These results suggest that acculturated Hispanic women may require the protective effects of IL-10 to prevent preterm birth, while nonacculturated Hispanic women may not. Though previous research has shown high IL-1 and IL-6 levels to increase the risk of preterm birth (Challis et

al., 2009; Lyon et al., 2010), we found no relationship between these cytokines and preterm birth in Hispanic women living in the United States. Hispanics. Similar to our previous report, IL-1RA levels increased with years in the United States, but this effect was not related to preterm birth rates (Ruiz, Stowe, Goluszko, Clark, & Tan, 2007). Together, these findings suggest that IL-10 plays a specialized role in preventing preterm birth in acculturated Hispanics.

Our study sheds new light on the relationship between acculturation and the “Hispanic paradox” (Markides & Coreil, 1986), which states that the health status of Hispanic individuals declines as levels of acculturation increase. In this paradigm, deleterious behaviors, risk factors, and unfavorable health conditions increase with greater acculturation (Lara, Gamboa, Kahramanian, Morales, & Bautista, 2005). For instance, acculturation in Hispanics leads to increased rates of depression, diabetes, and substance abuse. Given these factors are associated with increased levels of inflammation (Kiecolt-Glaser, Gouin, & Hantsoo, 2010), the anti-inflammatory effects of IL-10 may play a critical role in attenuating the negative health effects of the changing lifestyle in acculturated Hispanics (Lara et al., 2005).

Importantly, our findings in the current study support the hypothesis that IL-10 plays a protective role in pregnancy (Challis et al., 2009; Lyon et al., 2010). While a limited number of studies have reported that elevated IL-10 levels were associated with an increased risk of preterm birth (Apuzzio et al., 2004; Pearce et al., 2009), these investigations were conducted in different ethnicities and countries. Moreover, the current study focused on a very specific and high-risk sample population, acculturated Hispanics. As such, it is likely that the relationship between IL-10 and preterm birth is uniquely affected by acculturation.

The relationships among IL-10, preterm birth and acculturation may involve interactions with other anti-inflammatory pathways. In our prior study, we found that preterm birth was associated with decreased progesterone/estriol ratios in acculturated Hispanic women (Ruiz et al., 2008). Notably, progesterone upregulates IL-10 production by Th-2 T-lymphocytes in vitro (Piccinni et al., 1995). Thus, the increase in progesterone may directly stimulate the production of IL-10 and facilitate the Th-1-to-Th-2 shift observed during pregnancy. These data are consistent with recent studies demonstrating increased IL-10 production by T-cells as well as the placenta in the third trimester of pregnancy (Cadet, Rady, Tying, Yandell, & Hughes, 1995). As such, the increased risk of preterm birth in acculturated Hispanics is likely a result of the dual effect of decreased progesterone and IL-10.

In the current study, the interactions among acculturation, IL-10, and preterm birth were not influenced by potentially confounding variables such as cigarette smoking, BMI, infection, or marital status. However, these interactions are very complex, involving numerous other physiologic pathways and susceptible to influence from behavioral and external factors. Future studies should examine the possibility for additional interactions among IL-10, acculturation, other cytokine pathways, and stress systems, including the HPA axis.

In summary, our findings demonstrate that IL-10 is an important predictor of preterm birth in acculturated Hispanic women. More studies are needed to define the specific aspect of acculturation that affects IL-10 production and the interaction of IL-10 with other inflammatory pathways.

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Figure 1.
Schematic depicting the theoretical interaction among inflammation, acculturation, and preterm birth in Hispanic women living in the United States.

Figure 2.

The probabilities of preterm birth predicted by a logistic regression model with standard error of the differences. The risk for preterm birth increased with *years in the United States* in patients with undetectable IL-10 levels.

Figure 3. The probabilities of preterm birth predicted by a logistic regression model with standard error of the differences. The risk for preterm birth was higher in U.S.-born than foreign-born participants when IL-10 levels were undetectable.

Table 1

Demographic Characteristics, Inflammatory Markers, and Birth Outcomes

Demographic Variable	% Total (n = 470)	IL-1RA % Above		IL-6 % Above		Detectable IL-10 % Above	
		Median (n = 235)	Median (n = 232)	Median (n = 99)	% Preterm (n = 33)		
Age (years)							
< 18	6.0	71.4*	35.7	82.1	7.1		
18–34	91.3	48.6	50.8	78.6	7.2		
> 35	2.8	61.5	53.8	76.9	0.0		
Body mass index (kg/m ²)							
Normal (18–25 kg/m ²)	49.4	42.4*	41.4*	80.7	8.3		
Overweight (26–30 kg/m ²)	33.2	49.6	53.3	79.4	6.6		
Obese (>30 kg/m ²)	17.4	65.3	62.9	81.7	2.8		
Gravida							
1 pregnancy	27.6	49.2	40.2	79.5	8.6		
2 pregnancies	30.2	47.1	52.1	73.6	3.6		
3 pregnancies	22.9	49.0	54.8	82.9	9.4		
> 4 pregnancies	19.2	58.0	55.8	80.5	7.9		
Marital status							
Married	57.4	52.2	48.5	78.2	6.7		
Single	42.6	47.5	51.8	79.4	7.5		
History of preterm birth							
No	92.1	50.2	49.2	78.6	6.2*		
Yes	7.9	51.4	60.0	80.6	16.2		
Infection during pregnancy							
No	56.0	46.5	51.7	78.7	8.1		
Yes	44.0	54.4	48.7	78.2	5.2		
Medical insurance							
No	65.9	38.7*	53.8	79.3*	5.5		
Yes	34.1	72.2	42.8	77.2	10.1		
Acculturation							
Years in the U.S.							

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Demographic Variable	% Total (n = 470)	IL-IRA % Above		IL-6 % Above		Detectable IL-10 % Above		% Preterm (n = 33)
		Median (n = 235)	Median (n = 232)	Median (n = 232)	Median (n = 99)	Median (n = 99)	Median (n = 99)	
10	58.3	40.1 *	51.7	79.3	5.1			
> 10	41.7	64.6	47.7	77.9	9.7			
English proficiency								
Low	62.0	38.9 *	53.2	78.4	5.2 *			
High	38.0	68.9	44.9	79.1	10.1			
Born in the U.S.								
No	68.2	39.0 *	51.9	79.5	5.6			
Yes	31.8	74.3	46.3	77.0	10.1			

* Statistically significant at $p < .05$ using χ^2 .

Table 2
Logistic Regression Model for *Years in the United States Predicting Preterm Birth*

	Estimate	Standard Error	Wald Chi Square	Chi Square Probability	Odds Ratio with Confidence Intervals
Intercept	-0.92	1.38	0.44	0.51	
Years in U.S.	0.09	0.25	0.14	0.71	1.10 (0.67, 1.81)
Nondetectable IL-10	-0.32	0.68	0.23	0.63	0.72 (0.19, 2.72)
Years in U.S. X nondetectable IL-10	1.15	0.51	5.15	0.02	3.17 (1.17, 8.61)
Maternal age	-0.06	0.05	1.35	0.25	0.94 (0.85, 1.04)
Maternal BMI	-0.04	0.04	1.17	0.28	0.96 (0.89, 1.03)
Infection during pregnancy	-0.47	0.42	1.24	0.27	0.62 (0.27, 1.43)
History of preterm birth	0.94	0.59	2.57	0.11	2.56 (0.81, 8.06)
Gravida	0.12	0.17	0.51	0.48	1.13 (0.81, 1.57)
Gestational age (days) at which blood was drawn	0.06	0.10	0.35	0.55	1.06 (0.87, 1.30)
Currently married	0.54	0.42	1.63	0.20	1.71 (0.75, 3.90)

Note. BMI = body mass index.

Table 3
Logistic Regression Model for *Born in the United States* Predicting Preterm Birth

	Estimate	Standard Error	Wald Chi Square	Chi Square Probability	Odds Ratio with Confidence Intervals
Intercept	-1.80	1.42	1.61	0.20	
Born in U.S.	0.04	0.55	0.00	0.95	1.04 (0.35, 3.07)
Nondetectable IL-10	-1.32	1.05	1.58	0.21	0.27 (0.03, 2.09)
Born in U.S. X nondetectable IL-10	2.82	1.22	5.35	0.02	16.78 (1.54, 182.98)
Maternal age	-0.03	0.05	0.40	0.53	0.97 (0.87, 1.07)
Maternal BMI	-0.03	0.04	0.62	0.43	0.97 (0.90, 1.04)
Infection during pregnancy	-0.48	0.42	1.31	0.25	0.62 (0.27, 1.41)
History of preterm birth	0.92	0.58	2.51	0.11	2.51 (0.80, 7.82)
Gravida	0.13	0.17	0.64	0.43	1.14 (0.82, 1.58)
Gestational age (days) at which blood was drawn	0.05	0.10	0.28	0.60	1.06 (0.86, 1.29)
Currently married	0.50	0.42	1.40	0.24	1.65 (0.72, 3.78)

Note. BMI = body mass index.