

RESEARCH ARTICLE

Pregnant Mexican American Biopsychosocial/Cultural risks for adverse infant outcomes

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Abstract

Aims: To test a model of psychosocial/cultural/biological risk factors for poor birth outcomes in Latina pregnant women.

Design: An observational study measuring acculturation, progesterone, cortisol, cotinine, age, marital status, income, stress, depressive symptoms and coping. We tested a structural equation model to predict risk.

Methods: We obtained a convenience sample ($N = 515$) of low medical risk pregnant Mexican American Hispanic women at 22–24 weeks of gestation. Bilingual research nurses collected data from blood, urine and questionnaires. Self-report measures were the Beck Depression Inventory-II, the Perceived Stress Scale, the Acculturation Rating Scale for Mexican Americans-II and the Brief Coping. We measured progesterone and cortisol in plasma and cotinine levels in urine by enzyme-linked immunoassays.

Results: A PLS-SEM model revealed that Mexican American Hispanic pregnant women who were younger, single, lower income, more acculturated and who had greater negative coping, stress and depression were most at risk for having earlier and smaller babies.

KEYWORDS

advanced practice nursing, low birthweight, Mexican Americans, preterm birth, risk factors

1 | INTRODUCTION

Disparities in preterm birth (PTB - ≤ 37 weeks of gestation) exist for Hispanics living in the United States, most of whom are of Mexican origin (Pew Research Center, 2013). A recent report out of the Centers for Disease Control and Prevention (CDC) indicates that the total and late PTB rate (defined as 34–36 weeks of gestation) is increasing in the United States, including Hispanics (Martin et al., 2018). Specifically, the rate of PTB rose 5%, which is mainly due to the rise in late preterm infants. Infants delivered between 37 weeks

and 1 day and 38 weeks and 6 days, considered “early term,” are also at higher risk of infant morbidity and mortality compared with those born ≥ 39 weeks (Spong, 2013). Preterm and early-term infants are at risk for developmental and behavioural problems (Murray et al., 2017). The risks for early-term infants are less studied, particularly in relationship to brain development (Entringer et al., 2015).

Cultural, social and biological factors have been implicated in poor birth outcomes in Mexican American Hispanics (Lara et al., 2005). Hispanics of Mexican or Central American ancestry experienced an increase in PTBs after the 2016 U.S. presidential election, attributed

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to severe sociopolitical stressors (Krieger et al., 2018). After an immigration raid in Iowa, PTB also increased in Hispanics that were predominantly of Mexican descent (81%), although 11% were of Central American origin and 8% were of other Hispanic origin (Novak et al., 2017). The low birthweight (LBW) risk was worse for mothers with low education, which the authors surmised to have fewer coping resources. Investigators speculated that the pregnant Hispanics' neuroendocrine balance and coping resources were affected after the raid, leaving their infants vulnerable to a dysregulated endocrine environment. The international relevance of this topic is amplified by the ongoing immigration policies between the United States and Mexico and the stress it puts on Hispanics and their families. Internationally, studies (Lipsicas et al., 2012) have examined rates of suicide among immigrant groups coming into Europe. They found higher suicide rates in non-European immigrant females, suggesting there are difficulties in the acculturation process in Europe as well. In this paper, we evaluate a model of risk factors in Mexican American Hispanic pregnant women, hereafter referred to as Latinas, to understand the gravity of the risks and how those risks accumulate to increase the risk of poor birth outcomes.

1.1 | Background: factors related to risk

Acculturation and higher generational status increase the risk of adverse birth outcomes, particularly for Mexican Americans who account for most (65%) of Hispanic Americans (D'Anna et al., 2012; Fox et al., 2015, 2018). Acculturation—a transitional process that occurs as immigrant groups gain exposure to the beliefs, traits and lifestyles of the dominant culture—is considered a significant deleterious factor for maternal health (Ruiz et al., 2012). The effects of acculturation in Latinas are consistently linked to: (a) increased depression and stress (Ruiz et al., 2006; Ruiz, et al., 2012); (b) changes in reproductive hormones such as reduced progesterone and increased estradiol (Ruiz et al., 2008); (c) increased inflammation and infections (Ruiz, et al., 2012; Wommack et al., 2013); (d) changes in micro RNA (miRNA) expression profiles (Wommack et al., 2018); and (e) shorter gestational age/PTB in infants (Ruiz, et al., 2015).

Socio-economic factors are also associated with early delivery. It is well-documented that maternal age and PTB, younger and older women, are at greater risk for PTB (Behrman & Butler, 2007; Leonard et al., 2015). One study linked preconception life event stress and younger women with PTB (Witt et al., 2014). Additionally, financial stress from low income has been associated with poor infant outcomes (Joseph et al., 2014; Leonard et al., 2015), particularly for Latinas born in the United States (Leonard et al., 2015). Brumberg and Shah (2015) emphasize that poverty is a toxic stressor increasing PTB risk. Single pregnant women have a higher risk of early birth (Behrman & Butler, 2007), and this finding applies across ethnic groups and ages.

Psychological factors, such as perceived stress and depression and their relationship with PTB, are extensively studied with strong empirical evidence indicating links between prenatal stress and PTB

(Brumberg & Shah, 2015; Lilliecreutz et al., 2016). Systematic reviews reveal the associations between prenatal depression and poor infant outcomes at birth. Accortt et al. (2015) findings indicate relationships between maternal depression and PTB. Borders et al. (2007) studied 294 welfare recipients and found that poor coping skills were linked to LBW babies, suggesting women who used avoidant or maladaptive coping strategies (e.g. behavioural disengagement such as avoidance, denial) had a higher risk of poor infant outcomes. In general, pregnant women with coping behaviours of avoidance or distancing had more PTB and postpartum depression (Dole et al., 2004; Honey et al., 2003; Messer et al., 2005). Additionally, evidence indicates that first-generation Latinas use less active coping skills than acculturated Latinas (Ruiz, et al., 2015).

Multiple known biological factors are predictive of the risk of PTB. Based on earlier results related to the role of inflammation and PTB, progesterone is important as it counter regulates inflammation in pregnancy (Garry et al., 2018; Ruiz et al., 2008). This reproductive hormone is essential for pregnancy maintenance and is currently extensively used to prevent PTB (Navathe & Berghella, 2016; Ruiz et al., 2008). Another important PTB factor is the biological effect of smoking cigarettes, measured by cotinine, a biomarker of nicotine. One meta-analysis indicated a 25% increase in PTB for pregnant women who smoke (Shah et al., 2011). Smoking is also related to poverty and psychological distress, factors related to PTB (CDC, 2013). The mechanisms/pathways from smoking and psychological distress to PTB may be due to cotinine and cortisol, a biomarker of stress. Scientists (Davis et al., 2017; Entringer et al., 2015; Graham et al., 2019) have suggested that cortisol is a mediator of maternal emotional distress and brain development of the foetus. The authors state that changes in maternal cortisol concentrations with stress and depression affect foetal cortisol concentrations and potentially infant outcomes.

2 | THE STUDY

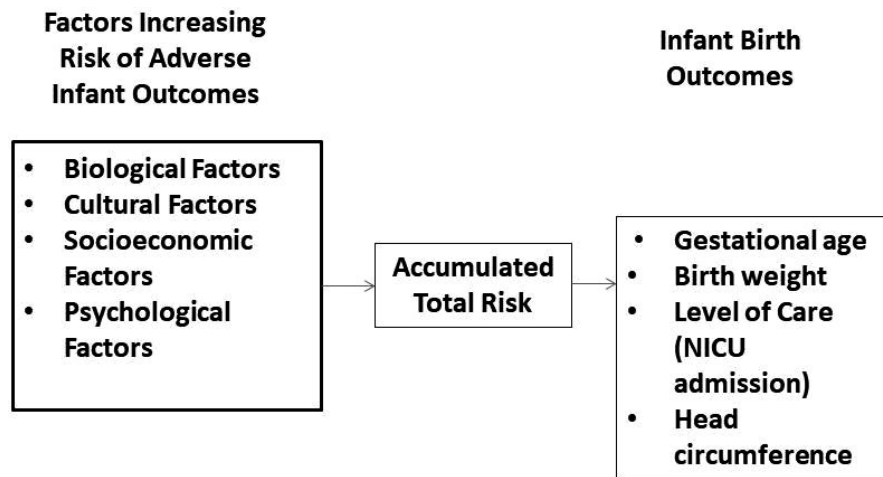
2.1 | Aims

The aim of this study was to evaluate the strength of predictive factors of risk for adverse infant outcomes in pregnant Latinas. Biologic, cultural, socio-economic and psychological factors were evaluated (see Figure 1). We hypothesized that the cultural factor (acculturation) was one of the major predictors increasing risk of adverse outcomes. The results of the model testing may assist in: (a) improved identification of pregnant Latinas who are at risk for poor infant outcomes and (b) identification of the need for targeted interventions to decrease the risks.

2.2 | Design

We used a prospective, observational design. Between 2008–2012, a convenience sample was recruited from multiple locations (six

FIGURE 1 Conceptual framework



private physician practices and two obstetrical clinics) in central Texas and the Houston coastal area. Providers first introduced the study to potential participants. For those interested, a bilingual research associate described the study and scheduled a data collection visit. At the data collection visit, the research nurse (RN) screened for inclusion criteria.

The RN collected data on all participants between 2–4p.m. to control for diurnal rhythms of cortisol. An ultrasound obtained at no >20 weeks of gestation (preferably <12 weeks of gestation) and the date of the last menstrual period confirmed length of gestation. This ensured recruitment and data collection at the proper gestational window. All questionnaires and samples were collected at 22–24 weeks of gestation. This gestational age is a critical window for the neuroendocrine system in the foetus and the effect of maternal stressors on placental functioning and neonatal outcomes (Davis et al., 2017; Ruiz et al., 2006; Wadhwa et al., 2011).

2.3 | Participants

Participants had the following methods of payment for their care: self-pay, Title V insurance (state funding), Medicaid or private insurance. The inclusion criteria included the following: (a) self-identified women of Mexican heritage; (b) ages 14–40; (c) carrying only one foetus; (d) able to read and speak English and/or Spanish; and (e) report residence in the United States for at least 10 years. The following exclusion criteria were used to minimize medically related risks for PTB: (a) diabetes; (b) chronic hypertension; (c) major psychiatric disorders such as schizophrenia or bipolar; (d) thyroid disorders; (e) use of steroids at the time of data collection; (f) foetal anomalies or uterine anomalies; (g) foetal demise; (h) placement of a cerclage; and (i) multiple gestations (twin and triplet gestation). Multiple gestations were excluded as they are thought to have a different mechanism (over distention) for PTB than other spontaneous PTB (Romero et al., 2015). History of spontaneous PTB was included as this is a known risk factor for repeat spontaneous PTB. We determined sample size via results

from the investigators' work and from criteria for number of cases needed for regression and structural equation modelling (Wetzels et al., 2009) to achieve adequate power of 0.80. We purposefully recruited women who had lived in the United States >10 years for this work, as in our first related study (Wommack et al., 2013) those were the women who had the most PTBs, our primary infant health outcome. A minimum sample size of 375 was needed and surpassed: the final sample size included $N = 515$ women to allow for missing data.

2.4 | Data collection

We collected data using questionnaires, prenatal charts, medical records and plasma samples of the participants. *Sociodemographic Factors and Clinical Data.* The RN collected demographic data for age, marital status, education level, annual income, insurance, public housing, use of food stamps and immigrant generation. To evaluate immigrant generation, the RN asked if the participant had been born in Mexico or the United States, or if her mother and/or grandmother had been born in Mexico. If the participant was born in Mexico, we considered her first generation. If the participant was born in the United States and her mother was born in Mexico, we considered her second generation. If both the participant and her mother were born in the United States, but her grandmother was born in Mexico, we considered her third generation. The RN evaluated the prenatal chart for obstetrical complications and infections. Study personnel administered the standardized questionnaires given in paper and pencil format either in Spanish or English to all participants. The RN guided the participants to use their best judgement in answering questions. She obtained 20 millilitres of whole blood from each participant via venipuncture. All blood samples were centrifuged at 2000 r.p.m. for 10 min, and the plasma was transferred to and stored in polypropylene tubes at -80°C . The RN obtained urine samples from the participants to test for cotinine as an indicator of cigarette smoking. Finally, after the birth of the baby, the RN obtained hospital delivery records.

2.4.1 | Depression

Depression was measured using the Beck Depression Inventory-II (BDI-II) (Beck et al., 1996). The BDI-II quantifies depressive symptoms and consists of 21-Likert items. Each item has a 4-point response option ranging from 0–3, with 63 as the highest possible total scale score. In English and Spanish versions from this sample, Cronbach's α was 0.89, indicating high reliability. The BDI-II has been used with pregnant populations (Pereira et al., 2014).

2.4.2 | Stress

The Perceived Stress Scale (PSS-10) was used to quantify the level for which participants found life unstable, unmanageable and overwhelming using a 5-point Likert scale (Cohen et al., 1983). The PSS has been used widely and applies to a diverse population, with pregnant women and with ethnically varied samples (Hoffman et al., 2016). Total scale scores range from 10–50, with higher scores indicating higher perceived stress. Cronbach's α for this sample was 0.79.

2.4.3 | Acculturation

The ARSMA-II was used to measure acculturation (Cuellar et al., 1995). The instrument evaluates the following: (a) preferred language; (b) identification of ethnicity; (c) behaviours related to ethnicity and cultural background; and (d) contact with Mexican American ethnicity. The ARSMA-II measured a total continuous acculturation level score from which we captured the dynamic process of acculturation. All questions used a Likert scale in either Spanish or English. Cronbach's α equalled 0.96.

2.4.4 | Coping

The Brief Coping has 28 questions to assess cognitive and behavioural coping (Carver, 1997). There are two items for each of 14 subscales with answers ranging from 1 “not doing this at all”–4 “doing this a lot.” The scale has both Spanish and English versions (Carver, 1997). A factor analysis (Ruiz, et al., 2015) indicated two major factors, active coping and disengaged coping with Cronbach's α of 0.86 and 0.78, respectively, for the English version and 0.92 and 0.70, for the Spanish version.

2.4.5 | Hormone and cotinine measurement

We drew blood for cortisol and progesterone. The time of mid-afternoon was based on previous studies with similar protocols for the time of day and gestational age (Davis & Sandman, 2010) and use of plasma for one sample (Sandman et al., 2006). Progesterone and cortisol levels were measured by enzyme-linked immunoassay

(ELISA) according to manufacturer's instructions with kits from Cal Biotech and read spectrophotometrically using a SpectraMax M2e reader (Molecular Devices LLC). Assay results were read spectrophotometrically using a μ -Quant Reader (Bio-Tek Instruments). The laboratory technician completed all de-identified assays blinded to names. Each analyte had an interassay and intra-assay variance of <15%. Cotinine levels in maternal urine were measured using The Sure Step™ One-Step Rapid Nicotine Test from Craig Medical Distribution Incorporation (Cat # NICX5C). A cut-off sensitivity level of 200 ng/mL was used for this immunoassay.

2.4.6 | Pregnancy outcomes

Infant outcomes obtained from the delivery record included gestational age at birth in weeks, infant birthweight in grams, head circumference in centimetres and level of care for NICU stay (yes/no). Our primary foci for the outcomes of this study were on babies born too early and too small.

2.5 | Ethical considerations

We obtained written consent from all participants to be in the study, to access their prenatal records and to retrieve their medical records after birth of the baby. The RN obtained informed written consent; persons 14–18 years of age provided child assent and parental consent. The Institutional Review Boards of the XXXX and the XXXXX approved the research protocol.

2.5.1 | Data analysis techniques

Descriptive data and correlations were analysed on SPSS version 25. As the range of values differed greatly among the various observed measures, the proportion of maximum scoring transformation (POMS) was used to place all variables on a common scale that ranged from 0–1: $X_{\text{POMS}} = (X - X_{\text{min}}) / X_{\text{max}}$. Importantly, POMS rescaling preserves variances and co-variances and does not alter the relationships among the variables but avoids potential pivoting problems during inversion of the solution matrices and aids model convergence (Little, 2013).

First, the conceptual structure of our 10 “risk factor” variables was verified by conducting a principal axis factor analysis using a Promax rotation to allow correlations between the factors. The number of dimensions was determined by the presence of initial Eigenvalues <1.

The structural equation model (SEM) of the data was constructed and tested using the SmartPLS software (Ringle et al., 2015). Listwise deletion of missing values for a conservative test of our hypothesis was employed (listwise $n = 399$). This software adopts a partial least squares (PLS) approach to SEM, a relatively recent alternative to traditional SEM methods. PLS-SEM is used to develop theories based

on maximizing the explained variance in dependent variables. The PLS-SEM approach was considered ideal for the present analysis in its unique ability to model an intricate hierarchy of latent variable constructs that would not be readily analysed using other statistical modelling frameworks. It is more flexible for complex models with higher-order constructs such as our proposed model (Ringle et al., 2015).

The PLS-SEM algorithm iterates through a four-step process: (a) assign initial scores to the latent variables based on equally weighted indicators; (b) assign weights to the structural paths connecting latent variables to maximize R-squared for the latent construct; (c) use structural weights (from step 2) to adjust latent variable scores (from step 1); and (d) adjust weights for measurement variables, connecting latent variables with their indicators. This four-step process continues until successive iterations do not produce significant changes in the measurement weights. This final set of weights is used to calculate final estimates for the latent variable scores, which are then used in OLS regression to calculate the final structural weights in the model. There have been in-depth discussions of PLS-SEM and comparisons with traditional SEM (Garson, 2016; Hair, 2017).

In designing the SEM model, factor analysis results were used as a starting point, treating the four identified factors as latent risk factor constructs. These risk factors were tested as predictors of a higher-order latent factor, the Cumulative Risk Profile. We hypothesized that the cumulative effect of biological, cultural, socio-economic and psychological risk factors would predict infant health outcomes, represented through a latent outcome construct of head circumference, birthweight, care level (NICU) and gestational age.

Finally, two latent coping constructs were created, representing the positive (PosCope) and negative coping (NegCope) strategies measured via the Brief COPE scale. These constructs were entered into the model as predictors of overall psychological risk. We hypothesized that psychological risk would be blunted by using positive coping strategies and magnified by the use of negative coping strategies.

2.5.2 | Reliability of measures and rigour for the study

All questionnaires had adequate reliability in this study. The biological measures also had acceptable interassay and intra-assay variance. All results were kept blinded from the RN to ensure rigour in the data collection.

3 | RESULTS

3.1 | Sample characteristics, descriptive results

The data for this sample were collected from 2008–2012 from the Gulf Coast and Central Texas. Table 1 describes the sample and descriptive statistics for the variables included in the factors for the

TABLE 1 Descriptive statistics for variables in the model

	Mean (SD) or %	Range	N
Cultural factors			
Acculturation level (ARSM)	2.93 (1.12)	1–5	511
Immigrant generation	2.27 (1.17)	1–4	497
Demographic or socio-economic factors			
Age	24.61 (5.81)	14–43	514
Income quartile			
\$ 0–\$ 14,000	23%	--	456
\$ 14,400–\$ 23,000	27%	--	
\$ 24,000–\$ 34,000	23%	--	
\$ 35,000–\$ 200,000	27%	--	
Marital status (%)			
Divorced or live alone	4.3%	--	515
Single live w/Parents	19.6%	--	
Live w/Significant other	27.4%	--	
Separated/Widowed	2.1%	--	
Married	46.6%	--	
Psychological factors			
Depression: BDI total	10.57 (7.27)	0–42	515
Perceived stress: PSS total	16.47 (5.71)	0–38	513
Brief cope: Positive coping	31.11 (8.01)	12–48	513
Negative coping	17.66 (4.85)	10–37	513
Biological factors			
Cotinine present	3% (17)	0–1	510
Cortisol (ln)	2.31 ng (0.28)	0.81–3.51	512
Progesterone	45.38 ng (4.77)	26.75–57.44	512
infant outcomes			
Care level: Admitted to neonatal intensive care unit	11% (31)	1–2	500
Gestational age (via ultrasound)	38.71 (1.94)	23.86–42.57	503
Birth head size (cm)	33.61 (1.75)	23.00–38.00	482
Birthweight (g)	3,256.88 (541.07)	650.00–4,534.00	503

model. The average week for start of prenatal care was 9.83 weeks, so this was not considered in the risk for PTB. Fifty-seven births were premature (≤ 37 weeks). Most were late preterm, born at 36–37 weeks and 6 were born at 35 weeks. There were seven babies born at 34 weeks and seven babies born between 30–34 weeks. Finally, there were four babies born between 23–30 weeks' gestation. Of the total sample, there were three women who were taking antidepressant medications of whom two delivered term and one delivered preterm at 27 weeks of gestation. There were 36 spontaneous PTBs with the rest being medically indicated. Eight of the PTBs were delivered due to preeclampsia or hypertension. Eight PTBs were delivered due to premature rupture of membranes. Two

TABLE 2 Factor loadings

	Factor 1: Cultural factors	Factor 2: Psychological factors	Factor 3: Socio-economic (Demographic) factors	Factor 4: Biological factors
Acculturation level ARSMA	0.97			
Immigrant generation	0.72			
Cotinine present				
Depression (BDI)		0.79		
Perceived stress (PSS)		0.68		
Income quartile			0.70	
Marital status			0.59	
Age			0.40	
Progesterone				0.81
Cortisol				0.49

Note: Principal axis factor analysis with Promax rotation. Loadings with absolute value <0.2 are suppressed for clarity. Factor 1 = 21% Variance; Factor 2 = 11% of Variance; Factor 3 = 9% of Variance; Factor 4 = 6% of Variance

of the PTBs had a mother who had gestational diabetes. Three of the PTBs were delivered due to poor biophysical profiles (BPP). A poor BPP result was determined from the following foetal indicators: (a) a non-reactive non-stress test; (b) decreased foetal breathing movements; (c) decreased gross foetal body movements; (d) decreased foetal tone; and (e) increased or decreased amniotic fluid volume (Manning et al., 1980). There were 164 infants born between gestational ages 37 and 0 days and 38 and 6 days, or early term. We included these infants as part of the analysis considering shortened gestational age.

Correlations may explain connections among factors. Greater Anglo acculturation (on ARSMA-II) was negatively related to age, indicating that younger women tended to be more acculturated in this sample ($r = -0.31$; $p < .001$). Income was significantly negatively related to greater immigrant generation ($r = -0.12$; $p < .001$). Immigrant generation was also related to both positive ($r = 0.21$, $p < .001$) and negative coping ($r = 0.13$, $p < .001$). Age ($r = 0.43$, $p < .001$) and income ($r = 0.38$, $p < .001$) were positively related to being married (versus not married). Marital status data were analysed as a dichotomous yes or no variable for the SEM model. Marital status was negatively related to immigrant generations ($r = -0.35$, $p < .001$)—indicating the higher the generation, the less the participants were married. Depression ($r = -0.13$, $p < .01$), stress ($r = -0.10$, $p < .01$) and both positive ($r = -0.13$, $p < .001$) and negative coping ($r = -0.11$, $p < .01$) were negatively related to age—indicating younger women had greater depressive and stress scores and scored higher on both types of coping. Negative coping was strongly related to depressive symptoms ($r = 0.52$, $p < .001$) and stress ($r = 0.44$, $p < .001$). Cotinine, the biomarker for smoking, was significantly positively related to acculturation ($r = 0.15$, $p < .001$), negatively related to income ($r = -0.11$, $p < .01$) and negatively related to marital status ($r = -0.15$, $p < .001$)—indicating more smoking with greater acculturation, less income and single status. Cortisol was positively related to immigrant generation ($r = 0.15$, $p < .001$) and negatively related to age ($r = -0.21$, $p < .001$) and marital status ($r = -0.17$, $p < .001$),

suggesting afternoon cortisol is related to greater generational status and is greater in younger, single women. Cortisol was not significantly related to stress ($r = 0.01$, $p = .73$) or to cotinine ($r = 0.08$, $p = .068$), so it is possible it did not affect the variance of stress in the psychological latent factor. Progesterone was negatively related to age ($r = -0.17$, $p < .001$), suggesting older women had less progesterone. Progesterone was also negatively related to the babies being in NICU ($r = -0.10$, $p < .01$). All birth outcomes had moderate to strong correlations with each other.

3.2 | Exploratory factor analysis

The factor analysis revealed four factors with initial Eigenvalues >1 , accounting for a cumulative 46.9% of the variance. Standardized factor loadings are presented in Table 2. Values below 0.2 in absolute magnitude are omitted for clarity. Based on the representative loadings, it appears that: Factor 1 is indicative of cultural factors (acculturation and immigration status); Factor 2 is indicative of psychological factors (depression and perceived stress); Factor 3 is indicative of socio-economic factors (income, age and marital status); and Factor 4 is indicative of biological factors (progesterone and cortisol).

3.3 | Structural equation model

The structural equation model (SEM) is represented by the path diagram in Figure 2. By convention, observed variables are depicted by rectangles, latent variables or constructs by circles and relations between variables by single-headed arrows. Numbers next to each arrow indicated the strength of the path between the variables, and numbers inside the circles indicate the internal consistency (Cronbach's alpha) for the construct. Significance tests and bootstrapped confidence intervals for all coefficients are listed in Table 3.

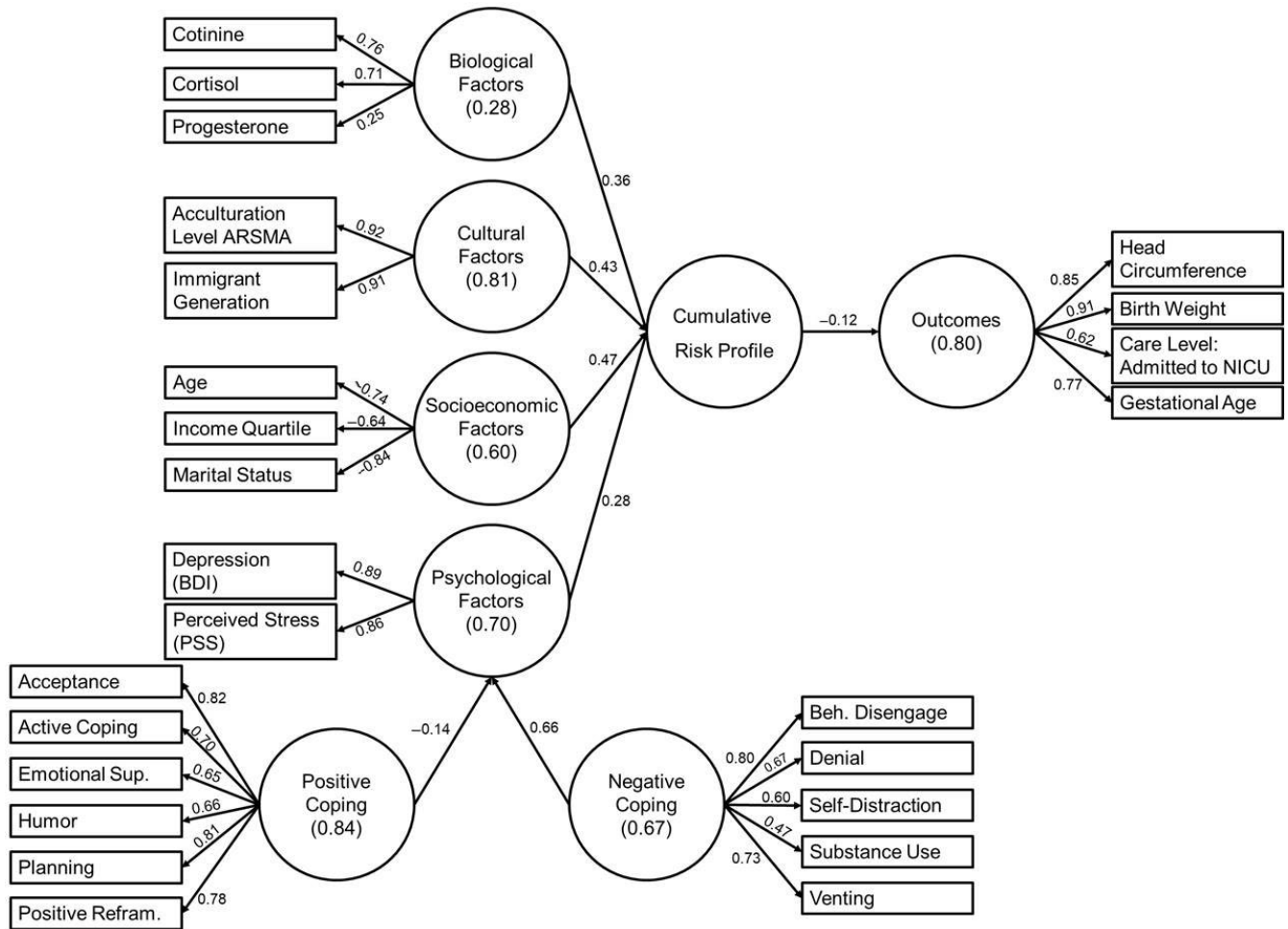


FIGURE 2 Structural equation model

TABLE 3 SEM model path coefficients

	Original sample	Bootstrapped sample mean (SD)	t	Bootstrapped confidence interval (bias corrected)
Biological factors ->Cumulative risk profile	0.36	0.37 (0.03)	11.32**	0.31 to 0.41
Cultural factors ->Cumulative risk profile	0.43	0.42 (0.03)	15.05**	0.39 to 0.48
Socio-economic (Demographic) Factors ->Cumulative risk profile	0.47	0.15 (0.44)	1.06	0.41 to 0.56
Psychological factors ->Cumulative risk profile	0.28	0.28 (0.05)	5.89**	0.18 to 0.34
Cumulative risk profile ->Outcomes	-0.12	-0.14 (0.07)	1.84*	-0.18 to 0.14
NegCope ->Psychological factors	0.66	0.65 (0.04)	17.93**	0.60 to 0.72
PosCope -> Psychological factors	-0.14	-0.10 (0.05)	2.53*	-0.29 to -0.10

Note: Significance testing based on bootstrapping with 500 resamples, one-tailed test.

*p < .05.

**p < .01.

There are eight latent variables in the model, and path coefficients are consistent with the overall conceptual model: biological, cultural, socio-economic and psychological factors create a combined *Cumulative Risk Profile*, with psychological factors also influenced by typical coping strategies. The Cumulative Risk Profile represents a higher-order construct, defined indirectly through the combined influence of the other latent factors.

Working from the left side of the model, we can see that biological, cultural, socio-economic and psychological latent constructs are all negatively framed. That is, higher latent scores would indicate more “risk” in each domain. The socio-economic factors/demographic factors, however, indicated that lower age, lower income and single marital status collectively had higher scores to predict risk.

The latent constructs, in turn, are positive predictors of Cumulative Risk, which is negatively related to neonatal outcomes.

Because PLS-SEM works by maximizing explained variance, rather than by matching covariance in a fixed theoretical model, there is some controversy about how to approach overall model fit (Henseler et al., 2016; Wetzels et al., 2009). First, for reference, we calculated a global goodness-of-fit (GoF) index, using the method described by Wetzels et al. (2009).

$$\text{GoF} = \sqrt{\text{Mean}(\text{AvgVarianceExtracted}) * \text{Mean}(R^2)}$$

This yields a GoF = 0.28 for the present study, which Wetzels et al. (2009) classify as a “medium” fit.

However, Henseler and colleagues argue that these global fit measures are unable to distinguish valid and invalid models within PLS-SEM (Henseler et al., 2016; Henseler & Sarstedt, 2013). Instead, these authors suggest evaluating a trio of scores across the latent constructs to assess overall model fitness: (a) *Average Variance Extracted* for the constructs is a proxy for convergent validity; (b) the *Heterotrait/Monotrait (HTMT) Ratio* is a proxy for discriminant validity; and (c) *Composite Reliability* as a proxy for model reliability.

These scores are presented across Tables 4 and 5—divided because the HTMT Ratio is assessed for pathways, rather than individual constructs. Significance tests were conducted via bootstrapping with 500 resamples (one-tailed tests). An examination of the t-test values in these tables indicates that the model does meet fitness criteria across all paths and constructs; that is, all scores are significant at $p < .05$ or better. Taken together, this means that the model shows good reliability, convergent validity and discriminant validity.

4 | DISCUSSION

Consistent with our hypotheses, poor birth outcomes were predicted by risk factors at multiple levels of analysis, including

biological, cultural, socio-economic and psychological. The tested empirical model had a good model fit and was scientifically rigorous. The model results suggest that each of the components in a latent factor is part of a whole picture of risk and is important to assess in terms of risk for poor infant outcomes. This study adds to the literature as it assesses the effect of cultural factors (acculturation) in Latina pregnant women as part of a risk model predicting adverse birth outcomes. The results support our hypothesis that acculturation is associated with higher levels of risk similar to well tested socio-economic/demographic factors from cross-sectional associations. One of the biggest take home messages of these results is that some sort of screening for acculturation at an initial obstetrical visit may be needed. In addition, we demonstrated that negative coping strongly predicts depression and stress, modifiable risk factors. These results suggest that development of interventions to improve coping may be needed. Moreover, a similar risk model may be tested for immigrants in different countries, such as in Europe, to see how it may need to be modified to understand the greatest risk factors.

The correlations revealed aspects of why the model is predictive. Acculturation had many relationships to parts of the model. The acculturation results were consistent with previous studies (Fox et al., 2015; Lara et al., 2005; Ruiz et al., 2006; Ruiz, et al., 2012). The ARSMA-II measured the level of acculturation—the higher the value, the higher the Anglo acculturation. As hypothesized, the greater the acculturation, the greater the prediction of risk. In our sample, those who were younger had higher acculturation scores compared with those who were older. In this study, greater acculturation level correlated with the participants being single; indeed, most participants in the total study (54%) were single.

The combined socio-economic factors had the greatest regression coefficient loading onto the profile of risk and prediction of poor infant birth outcomes. The finding that the socio-economic factor predicts risk is consistent with other previous work related to age, acculturation and income (Brumberg & Shah, 2015; Joseph et al., 2014; Leonard et al., 2015; Witt et al., 2014). From these data, being single, young, more acculturated and with low income

TABLE 4 Model Fitness 1, Avg variance extracted and composite reliability

	Average variance extracted			Composite reliability		
	Sample	Bootstrapped sample mean (SD)	t	Sample	Bootstrapped Sample Mean (SD)	t
Biological factors	0.38	0.39 (0.03)	12.39**	0.61	0.56 (0.16)	3.75**
Cultural factors	0.84	0.84 (0.01)	63.33**	0.91	0.91 (0.01)	116.20**
Negative cope	0.44	0.44 (0.02)	21.73**	0.79	0.79 (0.01)	56.14**
Outcomes	0.63	0.58 (0.10)	6.49**	0.87	0.83 (0.12)	7.25**
Positive cope	0.54	0.47 (0.11)	4.90**	0.88	0.81 (0.15)	5.67**
Psychological factors	0.77	0.77 (0.02)	39.53**	0.87	0.87 (0.01)	69.50**
Socio-economic (demographic) factors	0.55	0.55 (0.02)	26.95**	0.79	0.79 (0.01)	52.45**

Note: Significance testing based on bootstrapping with 500 resamples, one-tailed test.

* $p < .05$.

** $p < .01$.

TABLE 5 Model fitness 2, heterotrait/monotrait ratio

	Sample	Bootstrapped sample mean (SD)	t
Cultural factors -> Biological factors	0.38	0.38 (0.06)	6.55**
NegCope -> Biological factors	0.22	0.28 (0.06)	3.98**
NegCope -> Cultural factors	0.22	0.23 (0.05)	4.70**
Outcomes -> Biological factors	0.24	0.27 (0.08)	2.97**
Outcomes -> Cultural factors	0.08	0.11 (0.04)	2.27 [†]
Outcomes -> NegCope	0.11	0.15 (0.04)	2.89**
PosCope -> Biological factors	0.15	0.21 (0.05)	3.17**
PosCope -> Cultural factors	0.36	0.36 (0.06)	6.21**
PosCope -> NegCope	0.49	0.50 (0.05)	10.36**
PosCope -> Outcomes	0.08	0.11 (0.03)	2.67**
Psychological factors -> Biological factors	0.19	0.23 (0.08)	2.52 [†]
Psychological factors -> Cultural factors	0.11	0.12 (0.05)	2.41 [†]
Psychological factors -> NegCope	0.87	0.87 (0.04)	19.72**
Psychological factors -> Outcomes	0.08	0.10 (0.04)	1.76 [†]
Psychological factors -> PosCope	0.09	0.12 (0.04)	2.16 [†]
Socio-economic (demographic) Factors -> Biological factors	0.39	0.43 (0.08)	5.13**
Socio-economic (Demographic) factors -> Cultural factors	0.47	0.49 (0.06)	7.95**
Socio-economic (Demographic) factors -> NegCope	0.32	0.34 (0.06)	4.89**
Socio-economic (Demographic) factors -> Outcomes	0.13	0.16 (0.04)	3.10**
Socio-economic (Demographic) factors -> PosCope	0.20	0.22 (0.05)	3.90**
Socio-economic (Demographic) factors -> Psychological factors	0.38	0.38 (0.08)	5.00**

Note: Significance testing based on bootstrapping with 500 resamples, one-tailed test.

[†] $p < .05$.

** $p < .01$.

increases the risks for poor pregnancy outcomes. Basic questions can easily assess these factors in an initial obstetrical visit.

Depressive symptoms and perceived stress were related to socio-economic factors. Younger, single women with lower income had more stress and depressive symptoms. Younger women had more coping—either positive or negative. From these data, negative coping was related to being more acculturated, younger and single with lower income. These findings are consistent with other evidence of the effect of stress and depressive symptoms related to poor infant outcomes (Accortt et al., 2015; Borders et al., 2007; Lilliecreutz et al., 2016). Our findings suggest that prenatal assessment of stress and depressive symptoms should be part of a risk assessment for Latinas and consideration of treatment for moderate to high scores.

As anticipated, the psychological risk factors of perceived stress and depressive symptoms were strongly related to coping. Negative coping, especially behavioural disengagement and venting, increased stress and depressive symptoms. Positive coping including acceptance,

planning, positive reframing and active coping decreased stress and depressive symptoms. This is consistent with a large body of work demonstrating that effective coping strategies can act as a buffer against stressful life events (Cohen & Wills, 1985).

Smoking was positively related to greater levels of Anglo acculturation and positively related to being single and negatively related to income. Although smoking was not associated with levels of stress, it is important to acknowledge that only 3% of the women in our study were smokers. This may also account for the lack of significance of cotinine related to cortisol. Smoking as part of the risk profile for early birth matches empirical evidence linking smoking, stress and prematurity (CDC, 2013; Shah et al., 2011).

Consistent with the broader literature, those with higher levels of afternoon cortisol reported greater levels of acculturation compared with those who had lower levels of cortisol. As found in other studies, increased cortisol was related to acculturation and to poor birth

outcomes (D'Anna-Hernandez et al., 2012). Cortisol is one of the strongest physiological markers of stress.

The relationship of progesterone to cortisol was strong and is consistent with previously tested biological pathways of the endocrine system (Gibb & Challis, 2002). The fact that progesterone is part of the biological factors predicting poor birth outcomes is consistent with previous evidence and with current practice (Navathe & Berghella, 2016). Progesterone was also positively related to infants being in the NICU, such that negative (lower) levels of progesterone were related to the infant being admitted to intensive care rather than newborn nursery.

4.1 | Clinical implications for screening and intervention development

This research weighs the predictive ability of factors to increase risk. It adds to the literature related to risk for poor birth outcomes in Latinas, an understudied and vulnerable population. There are many factors that go into medical risk for poor pregnancy outcomes; however, many of the factors tested in this risk model are not evaluated in medical risk. In Latinas, risks such as level of acculturation need to be considered. Screening for identified risks found in this study might lead to improvements in practice. For example, screening for depression, stress and negative coping may pinpoint patients who would benefit from psychosocial interventions. To determine generational status, screening could begin with simple questions such as, "Where were you, your mother and your grandmother born?". Assessment of English proficiency may be easily determined to assess acculturation. Women who are <19, single and report low annual income (\$30,000 or less) also need to be considered at risk. A reliable screen for depressive symptoms and stress is also needed with non-pharmacological interventions for those women with moderate to high scores. Self-report questions about smoking are also important in risk identification. Further investigation is warranted about cortisol and progesterone levels due to the costs of laboratory testing and due to the changing levels of both biomarkers by gestational week.

4.2 | Limitations and future research directions

This study is not without limitations. It is from a single 2-week window in pregnancy and, as such, is limited to sampling from that period in gestation. The results are reflective of cross-sectional associations and thus cannot be considered truly causal. The participants were recruited from inner city private physician practices and may have different risk factors as compared with women who live in rural settings. Missingness at random may have limited the precision with which model estimates were derived. In addition, we did a one-time afternoon cortisol measurement in plasma that somewhat limits interpretation of results. Finally, we did not include pre-pregnancy BMI or nutritional status in this model of risk.

5 | CONCLUSIONS

These results may be used to be part of a scoring system of cumulative risk for poor infant outcomes in Mexican American Hispanics. Future research could test predictability of such a system for identifying the most high-risk patients. Development and testing of psychosocial interventions tailored to these results and targeted to Latinas (Ruiz et al., 2019) and to Mexican American Hispanics is vital to help prevent babies from being born too early and too small in this vulnerable population.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

The first author, RJR, obtained funding, oversaw the entire project, collected data, oversaw analysis and wrote the paper. MN analysed the data and wrote the Results section. RP and TM primarily wrote and edited the paper. KR worked with the research team during the entire project, helped with analysis interpretation and helped write and edit the paper. RPS was responsible for the accuracy of the biological results and helped write and edit the paper.

DATA AVAILABILITY STATEMENT

Data are available for use by contacting Dr. Ruiz, jruiz@microgen-labs.com.

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