

Acculturation and Adverse Birth Outcomes in a Predominantly Puerto Rican Population

Veronica Barcelona de Mendoza^{1,4}  · Emily Harville¹ · Katherine Theall² · Pierre Buekens¹ · Lisa Chasan-Taber³

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Abstract *Introduction* Latinas in the United States on average have poorer birth outcomes than Whites, yet considerable heterogeneity exists within Latinas. Puerto Ricans have some of the highest rates of adverse outcomes and are understudied. The goal of this study was to determine if acculturation was associated with adverse birth outcomes in a predominantly Puerto Rican population. *Methods* We conducted a secondary analysis of Proyecto Buena Salud, a prospective cohort study conducted from 2006 to 2011. A convenience sample of pregnant Latina women were recruited from a tertiary care hospital in Massachusetts. Acculturation was measured in early pregnancy; directly via the Psychological Acculturation Scale, and via proxies of language preference and generation in the United States. Birth outcomes (gestational age and birthweight) were abstracted from medical records ($n = 1362$). *Results* After adjustment, psychological acculturation, language preference, and generation was not associated with odds of preterm birth. However, every unit increase in psychological acculturation score was

associated with an increase in gestational age of 0.22 weeks ($SE = 0.1$, $p = 0.04$) among all births. Women who preferred to speak Spanish ($\beta = -0.39$, $SE = 0.2$, $p = 0.02$) and who were first generation in the US ($\beta = -0.33$, $SE = 0.1$, $p = 0.02$) had significantly lower gestational ages than women who preferred English or who were later generation, respectively. Similarly, women who were first generation had babies who weighed 76.11 g less ($SE = 35.2$, $p = 0.03$) than women who were later generation. *Discussion* We observed a small, but statistically significant adverse impact of low acculturation on gestational age and birthweight in this predominantly Puerto Rican population.

Keywords Acculturation · Latino · Preterm birth · Small-for-gestational-age

Significance

What is already known on this subject: Acculturation as a social determinant of health has been significantly associated with adverse birth outcomes among Latinos, yet little is known about ethnic subgroups such as Puerto Ricans.

What this study adds: After adjustment for important confounders, low acculturation was associated with lower gestational age and birthweight in this predominantly Puerto Rican population. It is important to consider acculturation and country of origin when studying perinatal health for Latinos.

Introduction

Racial and ethnic minorities in the United States are consistently at higher risk for a constellation of poor health indicators [34]. Latinos represent the largest minority

✉ Veronica Barcelona de Mendoza
barcelonaveronica@yahoo.com;
veronica.barcelona@yale.edu

¹ Department of Epidemiology, Tulane University School of Public Health and Tropical Medicine, 1440 Canal Street, Suite 2000, New Orleans, LA 70112, USA

² Department of Global Community Health and Behavioral Sciences, Tulane University School of Public Health and Tropical Medicine, 1440 Canal Street, Suite 2300, New Orleans, LA 70112, USA

³ University of Massachusetts- Amherst, School of Public Health and Health Sciences, 405 Arnold House, 715 N. Pleasant Street, Amherst, MA 01003, USA

⁴ Present Address: Yale School of Nursing, 400 West Campus Drive, Orange, CT 06477, USA

group and by 2043, the US will be a “majority minority” nation [40]. Latina women have slightly higher rates of preterm birth, low birthweight and small-for-gestational-age than non-Latina white women [24]. Within the category of Hispanic (Latino), however, lies a more complex picture of heterogeneity. Puerto Ricans have higher rates of preterm birth (13.2 %) than Central/South Americans (11.8 %) and women of Mexican descent (11.1 %), and higher rates of low birthweight (9.4 %) than Cuban, Central/South American and Mexican descended women [24].

Factors associated with adverse birth outcomes include medical and obstetric risk factors [21], stress and anxiety [25], and social determinants of health [14]. A less studied social determinant, acculturation, has been defined as “the process by which immigrants adopt the attitudes, values, customs, beliefs and behaviors of a new culture” [1]. Acculturation has been measured using linear (i.e., uni-dimensional) scales [23] which focus on behaviors and language and assume that as a person acculturates, they lose their identification with their original culture. Bi-dimensional measures include a wider variety of components that make up one’s cultural identification, and allow for biculturalism [22]. The Psychological Acculturation Scale (PAS) [37] is a bi-dimensional scale that focuses on psychological attachment to both cultures, and may be preferable as it incorporates the individual’s unique psychological response to cultural exposures.

Acculturation has been negatively related to risky health behaviors and adverse health outcomes [2]. Therefore, studies have suggested that when studying immigrant populations and risk of adverse perinatal outcomes, acculturation should be taken into consideration [5]. Our systematic review of published literature on the relationship between acculturation and birth outcomes in Hispanics¹ resulted in a total of 14 prior studies [2, 4, 5, 6, 9, 10, 13, 16, 17, 18, 20, 27, 30, 31]. While some studies found that increased acculturation measured via uni—[10] or bi-dimensional scales [6, 30], English language preference [30], or US birthplace [13, 30] led to increased risk of adverse birth outcomes, seven studies had null findings [2, 5, 9, 16, 18, 20, 27], and two found that US birthplace was associated with a decreased risk of adverse birth outcomes [4, 17].

However, the prior literature faced several important limitations. The majority of prior studies were cross-sectional [2, 4, 9, 13, 16, 17, 18, 27, 30], limiting the ability to identify the direction of associations. Only five prior studies utilized a bi-dimensional acculturation measure [5, 6, 9, 16, 30], and no studies used the PAS. The remainder

used language preference or birthplace as a proxy for acculturation. Only two [13, 18] were conducted among a predominantly Puerto Rican population. In the first, Engel et al. [13] utilized data from a national sample of 127,818 Puerto Rican women and found that Island born women had lower odds of low birthweight (OR 0.94 [0.89, 0.97]) and SGA (OR 0.93 [0.89, 0.97]) than women born on the mainland. In contrast, the second failed to find a statistically significant association between nativity and generation and risk of low birthweight among 1146 Puerto Rican mothers [18].

One possible explanation for these inconsistent findings is differences between Latino subgroups. Puerto Ricans have distinct migration patterns, culture and history from other Latinos, set apart primarily by the fact that they possess US citizenship. As such, Puerto Ricans are technically internal migrants when moving to the continental US, and their experiences as “immigrants” may not be the same as other Latinos in the US. The hallmarks of this circular migration pattern among Puerto Ricans include bilingual language skills and dual home bases both on the island the mainland [11]. Selective migration may be a contributing factor as well with studies indicating that lower acculturated Puerto Ricans who suffer from poor health may seek health care in the US [44]. Studies also find improved nutrition [41] and health [44] with increasing acculturation. The social/community networks of Puerto Ricans that reinforce positive health behaviors may also be stronger in the US due to broadened economic opportunities, extended kinship networks and flexibility of cultural identity [11].

In terms of birth outcomes, unlike Mexican Americans, island-born Puerto Ricans have worse birth outcomes [4, 17] than those born in the U.S. Consistent with these observations, in a study of New York vital records, island-born Puerto Rican women had a higher risk of preterm birth than women who were born on the mainland [17]. Similarly, in an analysis using New York City PRAMS data, Almeida et al. [4] found that island-born Puerto Ricans had higher odds of low birthweight (OR 1.72 [0.73, 4.06]) than US born whites, as did mainland born Puerto Ricans (OR 1.17 [0.6, 2.09]), although these results were not statistically significant. Finally, Acevedo-Garcia et al. [2] reported increased odds of low birthweight for island-born women compared to US born Puerto Ricans using a national sample (OR 1.08 [1.00, 1.16]), although this was not statistically significant. These findings suggest that biculturalism and higher acculturation may in fact be protective for birth outcomes among Puerto Rican women.

In light of the fact that previous studies did not assess psychological acculturation and that few focused on Puerto Ricans, we investigated if psychological acculturation and proxies of acculturation were associated with adverse birth

¹ Systematic Review conducted in MEDLINE and PsycINFO, using the keywords “Hispanics”, “Latinos”, “Acculturation” and “pregnancy”, with publication dates from 2000 to 2014.

outcomes in a sample of predominantly Puerto Rican women. We hypothesized that bicultural and higher acculturated women would have a lower risk of preterm birth and small for gestational age infants than lower acculturated women.

Methods

Proyecto Buena Salud (PBS) was a prospective study conducted among Hispanic prenatal care patients from 2006 to 2011. Details on the PBS have been published elsewhere [8]. The study was based in the public obstetrics and gynecology clinic and midwifery practice at a large tertiary care facility in Western Massachusetts which serves a predominantly Puerto Rican population. The overall goal of PBS was to examine how physical activity and psychosocial stress influenced risk of gestational diabetes mellitus. Eligibility was restricted to women of Puerto Rican or Dominican Republic heritage (Caribbean Islanders). Women who: (1) were themselves born in the Caribbean Islands, or (2) had a parent born in the Caribbean Islands, or (3) had at least 2 grandparents born in the Caribbean Islands were included. Exclusion criteria included (1) inability to speak English or Spanish, (2) current medications that could affect glucose tolerance, (3) multiple gestation, (4) history of chronic renal disease, hypertension, diabetes or heart disease, and (5) age <16 years or >40 years.

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 (in English or Spanish) as approved by the Institutional Review Boards of the corresponding clinical and academic institutions, and were performed in accordance with the ethical standards laid down in the Declaration of Helsinki. In order to minimize language barriers, face-to-face interviews were conducted in the participant's preferred spoken language, and answers were recorded on language-corresponding paper surveys. At the time of recruitment, interviewers collected information on socio-demographic factors, pre-pregnancy BMI, physical activity, psychosocial stress, cigarette smoking, and acculturation. After delivery, medical records were abstracted for medical and obstetric history, clinical characteristics of the current pregnancy, and birth outcomes. Exempt status was received by the relevant University's Institutional Review Board for this secondary analysis.

A total of 1583 prenatal care patients were eligible and enrolled in PBS between January 2006 and October 2010. For the current analysis, we excluded 68 participants who experienced a miscarriage, and 8 with multiple gestations. Six women were missing information on all exposure

variables (PAS, preferred language and generation in the United States), and 139 participants were missing delivery information (i.e. didn't deliver at the study hospital) resulting in a final sample of 1362 for analyses.

Assessment of Acculturation

Acculturation was measured directly via the Psychological Acculturation Scale [37], a 10-item bi-dimensional instrument that measures psychological attachment to and belonging within the Anglo-American and Latino/Hispanic cultures. Item responses are scored on a Likert-type scale ranging from 1 (only Hispanic/Latino) to 5 (only Anglo/American). Examples of questions include, "With which group do you feel you share most of your beliefs and values?", "With which group do you feel you have the most in common?", and "With which group do you feel the most comfortable?" The PAS has high internal consistency, with alpha coefficients of 0.90 (Spanish) and 0.83 (English) in Puerto Rican populations [37].

We defined scores less than three as low acculturation to the Anglo/American culture, a score equal to three as bicultural identification (equally Hispanic/Latino and Anglo/American), and scores greater than three as high acculturation to the Anglo/American culture, as have others [8]. We also created a dichotomized acculturation variable (low acculturation = less than 3 and high acculturation = greater than or equal to three). Finally, we calculated the mean PAS scores across all 10 questions to create a continuous psychological acculturation score with increasing score indicating increasing acculturation to the Anglo/American culture.

Proxy measures of acculturation included preferred language (dichotomous English/Spanish) and generation in the United States which was defined as first (i.e., participant born in Puerto Rico/Dominican Republic), second (i.e., participant born in the mainland US, but at least one parent born in Puerto Rico/Dominican Republic) or third (i.e., participant and at least one parent born on the mainland, but at least two grandparents born in Puerto Rico/Dominican Republic), and as have others [7, 12]. Generation was examined as both a three-level categorical variable and a dichotomous variable (first generation vs. second or third generation).

Assessment of Birth Outcomes

After delivery, information on birth outcomes was obtained from medical records by abstractors who were blinded to information on acculturation and other exposures. Preterm birth was diagnosed by the hospital obstetricians based on their best clinical estimate of gestational age, which was typically determined by: (1) ultrasound if available, and (2)

last menstrual period when ultrasound information was not available. The study obstetrician confirmed preterm birth status for all infants born at 37 weeks gestation or less [43]. Low birthweight infants were those with a birthweight less than 2500 grams and small-for-gestational-age was defined as a birthweight less than the 10th percentile for gestational age using gestational age-specific infant birthweight reference values from a population-based Hispanic sample [3]. Gestational age at delivery and birthweight were also examined as continuous variables.

Assessment of Covariates

Covariates included maternal age, education, annual household income, parity, cigarette smoking, living with a partner, marital status, medical complications in a prior pregnancy, and history of preterm birth. Health insurance was not considered as a covariate for analyses as 99 % of the sample had private or public insurance.

Statistical Analysis

We conducted a complete case analysis and therefore limited the dataset to women who had data on at least one of three exposure variables (i.e., psychological acculturation, language preference, generation in the United States) as well as at least one outcome variable (i.e., birthweight, gestational age). Bivariate associations between exposure, outcome and covariates were examined using Chi square tests for categorical variables and *t* tests for continuous variables. Unadjusted and adjusted multivariable logistic regression was employed to examine birth outcomes as dichotomous outcomes. Unadjusted and adjusted multivariable linear regression was utilized to examine continuous birthweight and gestational age. Each measure of acculturation was included independently in regression models. Potential confounders were identified via a priori knowledge and Directed Acyclic Graphs (DAGs) [35] which utilize graphs to represent relationships between covariates and minimize bias in epidemiologic studies [33]. Based on DAGs, the following covariates were included in multivariable models: age, education and living with a partner. Additional assessment of confounders using 10 % change in estimate methods [19] identified a consistent set of covariates. Finally, as a sensitivity analysis, we repeated the analysis only among nulliparous participants.

Factor analysis revealed that the first two questions on the PAS [“With which culture do you (1) share the most beliefs or values, and (2) have the most in common with”] represented the majority of the variance. Cronbach’s alpha was 0.87, demonstrating good internal consistency. The reliability of the Spanish PAS was 0.84, and English was

0.85. All analyses were conducted using SAS 9.3 (Cary, N.C.).

Results

The final sample of 1362 women were mainly low acculturated, with a mean level of psychological acculturation of 2.4 ± 0.6 . Approximately 24 % of women preferred Spanish, and 47 % were first generation in the US (island born). Preterm birth occurred in 9.9 % of women, low birthweight in 8.3 % and small-for-gestational age in 12.7 %. A total of 10.9 % of women were married and 51.2 % were living with a partner or spouse. The majority of participants were young (under age 24), nulliparous and had completed high school (Table 1).

Women who preferred to speak Spanish were more likely to have low psychological acculturation (as measured by the PAS) as compared to women who preferred English ($p < 0.0001$). Women born in Puerto Rico/Dominican Republic (first generation) were more likely to have low psychological acculturation as compared to women who were second and third generation ($p < 0.0001$). None of the other socio-demographic or behavioral covariates were significantly associated with acculturation (Table 2).

We examined the relationship between acculturation and birth outcomes in multivariable analyses (Table 3). After adjustment for age, education, and living with a partner, women with lower levels of psychological acculturation had a higher odds of preterm birth (aOR 1.62 [0.90, 2.91]) than high acculturated women, although this was not statistically significant. Women who preferred to speak Spanish (aOR 1.34 [0.86, 2.09]) or who were first generation in the US (aOR 1.43 [0.95, 2.14]) had a higher odds of preterm birth, but again these results were not statistically significant. In terms of small-for-gestational-age, women who preferred Spanish had an increased odds (aOR 1.23 [0.82, 1.84]) compared to those with English language preference, although this was not statistically significant.

We then evaluated the association between the acculturation measures and the continuous outcomes of gestational age and birthweight (Table 4). After adjustment for age, education and living with a partner, every unit increase in psychological acculturation (PAS score) was associated with an increase in gestational age of 0.22 weeks (SE = 0.1, $p = 0.04$) among all births. Women who preferred to speak Spanish had significantly lower gestational age babies (adjusted beta = -0.39 , SE = 0.2, $p = 0.02$) than women who preferred English. Women who were first generation in the US had significantly lower gestational age babies (adjusted beta = -0.33 , SE = 0.1, $p = 0.02$) as compared to women who were later generation. In terms of

Table 1 Baseline characteristics of study population, Proyecto Buena Salud, 2006–2011, N = 1362

	Total sample*		Missing
	n	%	
<i>Primary exposures</i>			
Psychological Acculturation Scale (PAS)			
Low <3	917	79.4	207
High ≥3	238	20.6	
Low (<3)	917	79.4	207
Bicultural (3)	91	7.9	
High (>3)	147	12.7	
Continuous PAS Score (mean, SD) ^a	2.4	0.6	207
Language preference for speaking/reading			
Spanish	314	24.4	76
English	972	75.6	
Generation in the United States ^b			
1st generation	622	47.1	42
2nd or 3rd generation	698	52.9	
Generation in the United States ^b			
1st generation	622	47.1	42
2nd generation	622	47.1	
3rd generation	76	5.8	
<i>Primary outcome variables</i>			
Preterm birth			
No	1227	90.2	1
Yes	134	9.9	
Gestational age at delivery (mean, SD)	39	2.6	1
Low birthweight			
No	1233	91.7	18
Yes	111	8.3	
Birthweight (mean, SD)	3198.5	602.2	18
Small for gestational age			
No	1174	87.3	18
Yes	170	12.7	
<i>Primary covariates</i>			
Age			
16–19	426	31.3	0
20–24	533	39.1	
25–29	240	17.6	
≥30	163	12.0	
Education			
<High school	596	48.6	136
High school graduate	398	32.5	
Some college/graduate	232	18.9	
Annual household income			
≤\$15,000	365	58.4	737
>\$15,000–\$30,000	184	29.4	
>\$30,000	76	12.2	
Live with partner/spouse			
No	591	48.8	151

Table 1 continued

	Total sample*		Missing
	n	%	
Yes	620	51.2	
Any smoking in pregnancy			
No	1046	84.2	119
Yes	197	15.9	
Parity			
Nulliparous	565	41.6	3
1	406	29.9	
≥2	388	28.6	
Pregnancy complications ^c			
None	1284	95.6	19
Yes	59	4.4	
History of preterm birth			
No	1198	89.6	25
Yes	139	10.4	

^a Increasing score indicates increasing acculturation to the Anglo/American culture

^b 1st generation—participant born in PR/DR; 2nd generation—participant born on mainland and at least one parent born in PR/DR; 3rd generation—participant and at least one parent born on the mainland, but at least two grandparents born in PR/DR (PR Puerto Rico, DR Dominican Republic)

^c History of previa, pre-eclampsia, toxemia, or uterine infection in a prior pregnancy

* Numbers may not sum to 100 due to rounding

the association between acculturation measures and birthweight, women who reported ‘bicultural’ levels of psychological acculturation had babies 201.7 grams (SE = 77.8, $p = 0.01$) less than women with high psychological acculturation in adjusted analyses (Table 4). Finally, women who were first generation in the US had babies who weighed 76.11 g less (SE = 35.2, $p = 0.03$) than women who were second generation or later.

Finally, we repeated the above analyses among nulliparous participants only (N = 565) and adjusted for the same confounders of age, education and living with a partner. We found no significant differences compared to our primary analyses.

Discussion

In this prospective study of predominantly Puerto Rican women, we found that after adjustment for important risk factors, lower levels of acculturation as measured by psychological acculturation, language preference, and generation in the US had a small, but statistically significant, adverse impact on gestational age and birthweight.

Table 2 Bivariate associations by level of acculturation, Proyecto Buena Salud, 2006–2011

	Psychological Acculturation Scale*				<i>p</i> value**
	Low (1 to <3) (<i>n</i> = 917)		High (≥3) (<i>n</i> = 238)		
	<i>n</i>	%	<i>n</i>	%	
<i>Language preference for speaking/reading</i>					
Spanish	263	30.2	14	6.3	<.0001
English	609	69.8	210	93.8	
<i>Generation in the United States^a</i>					
1st generation	464	52.6	66	28.5	<.0001
2nd or 3rd generation	418	47.4	166	71.6	
<i>Generation in the United States^a</i>					
1st generation	464	52.6	66	28.5	<.0001
2nd generation	381	43.2	143	61.6	
3rd generation	37	4.2	23	9.9	
<i>Age</i>					
16–19	296	32.3	66	27.7	0.49
20–24	357	38.9	99	41.6	
25–29	165	18	42	17.7	
≥30	99	10.8	31	13	
<i>Education</i>					
<High school	446	48.6	108	45.6	0.63
High school graduate	299	32.6	79	33.3	
Some college/graduate	172	18.8	50	21.1	
<i>Annual household income</i>					
≤\$15,000	272	59.7	82	56.9	0.59
>\$15,000–\$30,000	132	29	41	28.5	
>\$30,000	52	11.4	21	14.6	
<i>Living with partner</i>					
No	476	52.4	110	47	0.14
Yes	433	47.6	124	53	
<i>Any smoking during pregnancy</i>					
No	759	85.3	187	82	0.22
Yes	131	14.7	41	18	
<i>Parity</i>					
Nulliparous	388	42.4	94	39.8	0.28
1	288	31.4	68	28.8	
>2	240	26.2	74	31.4	

^a 1st generation—participant born in PR/DR; 2nd generation—participant born on mainland and at least one parent born in PR/DR; 3rd generation—participant and at least one parent born on the mainland, but at least two grandparents born in PR/DR (*PR* Puerto Rico, *DR* Dominican Republic)

* Numbers may not sum to 100 due to rounding

** *p* values generated from Chi square tests

Findings for acculturation and risk of preterm birth, low birthweight, and SGA were not statistically significant.

These findings are consistent with some [2, 4, 17, 18] but not all [5, 6, 9, 10, 13, 16, 20, 27, 30, 31] prior studies on acculturation and Latina women. There are several potential explanations for differences in study findings. First, prior studies varied widely in the tools used to

measure acculturation as well as in their study populations. No previous studies used the PAS and few focused on Puerto Ricans. Puerto Ricans may be more influenced by the US culture due to their legal relationship as a US territory and official languages of both English and Spanish [32]. Differences in socioeconomic status among Latino subgroups could also potentially explain differences in

Table 3 Adjusted odds ratios and 95 % confidence intervals from multivariable logistic regression models for the effects of acculturation variables on adverse birth outcomes, Proyecto Buena Salud, 2006–2011

Multivariable logistic models ^a	Preterm birth				Small for gestational age			
	Cases		OR	95 % CI	Cases		OR	95 % CI
	n	%			n	%		
<i>Psychological Acculturation Scale (PAS)</i>								
PAS—2 level								
Low (<3)	86	86.0	1.62	[0.90, 2.91]	111	78.7	1.0	[0.62, 1.50]
High (≥3)	14	14.0	1.0	Reference	30	21.3	1.0	Reference
PAS—3 level								
Low (<3)	86	86.0	1.13	[0.60, 2.13]	111	78.7	0.73	[0.44, 1.21]
Bicultural (3)	2	2.0	0.25	[0.05, 1.14]	7	5.0	0.42	[0.17, 1.05]
High (>3)	12	12.0	1.0	Reference	23	16.3	1.0	Reference
Continuous PAS Score (mean, SD) ^b	2.3	0.6	0.77	[0.56, 1.05]	2.4	0.7	1.07	[0.81, 1.41]
Language preferred for speaking/reading								
Spanish	37	28.7	1.34	[0.86, 2.09]	42	26.1	1.23	[0.82, 1.84]
English	92	71.3	1.0	Reference	119	73.7	1.0	Reference
Generation in the United States ^c								
1st generation	68	52.3	1.43	[0.95, 2.14]	73	44.0	0.90	[0.63, 1.28]
2nd or 3rd generation	62	47.7	1.0	Reference	93	56.0	1.0	Reference
Generation in the United States ^c								
1st generation	68	52.3	1.58	[0.61, 4.12]	73	44.0	1.06	[0.48, 2.33]
2nd generation	57	43.9	1.12	[0.43, 2.94]	85	51.2	1.20	[0.55, 2.63]
3rd generation	5	3.9	1.0	Reference	8	4.8	1.0	Reference

OR odds ratios, CI confidence intervals

^a Each acculturation variable was included in independent multivariable logistic regression models adjusted for age, education and living with a partner

^b Increasing score indicates increasing acculturation to the Anglo/American culture

^c 1st generation—participant born in PR/DR; 2nd generation—participant born on mainland and at least one parent born in PR/DR; 3rd generation—participant and at least one parent born on the mainland, but at least two grandparents born in PR/DR (PR Puerto Rico, DR Dominican Republic)

study findings. As compared to other Hispanics, Puerto Ricans and Dominicans experience the greatest health disparities, lower levels of education and income, and exhibit more adverse behaviors such as poor nutrition [25].

Weaker social networks among newly arrived Puerto Ricans may explain poorer birth outcomes among low acculturated women. Puerto Ricans with higher levels of acculturation and economic assimilation may have better health [44], and it is plausible that social network formation is different among Puerto Ricans due to circular migration. Research among Mexican born women has shown that living in immigrant enclaves is associated with lower rates of low birthweight [26]. This effect may be similar among Puerto Ricans, but research is sparse. We adjusted for social support via including living with a partner or spouse in our models, however, this may have been an incomplete measure.

While the majority of women in our study reported low psychological acculturation, they preferred to speak and read English. Proxy measures such as language and generation have limited scope and sensitivity [15] and may measure other constructs that are unrelated to acculturation [36]. Preferred language may be related to access to health care and language of service provision [42]. Therefore, multiple measures of acculturation are recommended as it is a complex phenomenon [38].

There are several strengths and limitations to this study. To our knowledge, this was the first study to use the PAS to investigate whether acculturation was associated with adverse birth outcomes in a predominantly Puerto Rican population. There was evidence of good reliability of the PAS in this sample. Other strengths included the prospective nature of the study, considerable sample size and high participation rates. However, we did not have information

Table 4 Adjusted beta coefficients, standard errors and *p* values from multivariable linear regression models for the effects of acculturation variables on gestational age and birthweight, Proyecto Buena Salud, 2006–2011

Multivariable linear models ^a	Gestational Age (weeks) (n = 1361 in final model)			Birthweight (grams) (n = 1344 in final model)		
	<i>B</i>	<i>SE</i>	<i>p value</i>	<i>B</i>	<i>SE</i>	<i>p value</i>
<i>Psychological Acculturation Scale (PAS)</i>						
PAS—2 level						
Low (<3)	−0.26	0.2	0.12	−38.59	42.5	0.36
High (≥3)	Reference			Reference		
PAS—3 level						
Low (<3)	−0.12	0.2	0.56	38.99	51.9	0.45
Bicultural (3)	0.37	0.3	0.24	201.67	77.8	0.01
High (>3)	Reference			Reference		
Continuous PAS Score (mean, SD) ^b	0.22	0.1	0.04	18.30	26.7	0.49
Language preferred for speaking/reading						
Spanish	−0.39	0.2	0.02	−67.43	41.4	0.10
English	Reference			Reference		
Generation in the United States ^c						
1st generation	−0.33	0.1	0.02	−76.11	35.2	0.03
2nd or 3rd generation	Reference			Reference		
Generation in the United States ^c						
1st generation	−0.53	0.3	0.09	−158.43	76.6	0.04
2nd generation	−0.23	0.3	0.46	−92.04	76.0	0.23
3rd generation	Reference			Reference		

β Beta coefficient, *SE* standard error

^a Each acculturation variable was included in independent multivariable linear regression models adjusted for age, education and living with a partner

^b Increasing score indicates increasing acculturation to the Anglo/American culture

^c 1st generation—participant born in PR/DR; 2nd generation—participant born on mainland and at least one parent born in PR/DR; 3rd generation—participant and at least one parent born on the mainland, but at least two grandparents born in PR/DR (*PR* Puerto Rico, *DR* Dominican Republic)

on length of time spent in the US or migration patterns before and during pregnancy, however psychological acculturation may be a better predictor of cultural behaviors and preferences than percentage of lifetime in the US [37]. Although errors in measurement of gestational age could affect our findings, we used the gold standard for measurement of this outcome, and expect that the sensitivity of disease diagnosis is the same in the exposed (high acculturated) and unexposed (low acculturated) groups. In this case, we would expect this to bias our findings toward the null [29].

We were unable to adjust for racial discrimination. Although the negative health effects of racial discrimination have been documented among Latinos [28], no studies were found that compared experiences of Puerto Ricans versus other Latino subgroups.

Selective migration is also a potential limitation, however women in our sample had lower rates of preterm birth (9.9 vs. 12.7 %) and low birthweight (8.3 vs. 9.4 %) compared to Puerto Ricans on the mainland based upon nationally representative data [24]. This reduces the threat

of selective migration although the study eligibility criteria was restricted to healthy women with no cardiovascular, renal disease, or diabetes.

Finally, Proyecto Buena Salud utilized the overall category of “Caribbean Islanders” to be consistent with census categories [10] and therefore included both Puerto Ricans and Dominicans but did not distinguish between the two. However, according to US census data, 93.0 % of citizens of Caribbean heritage in Springfield, Massachusetts are of Puerto Rican origin [39].

In summary, in this prospective cohort of predominantly Puerto Rican women we found that low acculturation was associated with lower gestational age and birthweight and a possible increased risk of adverse birth outcomes. This study contributes to the literature by examining birth outcomes in an understudied ethnic group and demonstrates the need for more research in this area focusing on the acculturative differences within the category of Latinos in the US. Future research should utilize prospective designs and include measures of acculturation, nativity and ethnicity when studying health disparities in birth outcomes.

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Compliance with Ethical Standards

Conflict of interest The authors declare they have no conflicts of interest.

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