Biological Research for Nursing
2017, Vol. 19(1) 28-35

DOI: 10.1177/1099800416672005
journals.sagepub.com/home/brn
SAGE

Acculturation Predicts Negative Affect and Shortened Telomere Length

R. Jeanne Ruiz, PhD, WHNP-BC, FAAN[1], Jerome Trzeciakowski, PhD[2], Tiffany Moore, PhD, RN[3], Kimberly S. Ayers, MS[1], and Rita H. Pickler, PhD, RN, PNP-BC, FAAN[4]

Abstract

Chronic stress may accelerate cellular aging. Telomeres, protective "caps" at the end of chromosomes, modulate cellular aging and may be good biomarkers for the effects of chronic stress, including that associated with acculturation. The purpose of this analysis was to examine telomere length (TL) in acculturating Hispanic Mexican American women and to determine the associations among TL, acculturation, and psychological factors. As part of a larger cross-sectional study of 516 pregnant Hispanic Mexican American women, we analyzed DNA in blood samples ($N = 56$) collected at 22–24 weeks gestation for TL as an exploratory measure using monochrome multiplex quantitative telomere polymerase chain reaction (PCR). We measured acculturation with the Acculturation Rating Scale for Mexican Americans, depression with the Beck Depression Inventory, discrimination with the Experiences of Discrimination Scale, and stress with the Perceived Stress Scale. TL was negatively moderately correlated with two variables of acculturation: Anglo orientation and greater acculturation-level scores. We combined these scores for a latent variable, acculturation, and we combined depression, stress, and discrimination scores in another latent variable, "negative affectivity." Acculturation and negative affectivity were bidirectionally correlated. Acculturation significantly negatively predicted TL. Using structural equation modeling, we found the model had an excellent fit with the root mean square error of approximation estimate = .0001, comparative fit index = 1.0, Tucker–Lewis index = 1.0, and standardized root mean square residual = .05. The negative effects of acculturation on the health of Hispanic women have been previously demonstrated. Findings from this analysis suggest a link between acculturation and TL, which may indicate accelerated cellular aging associated with overall poor health outcomes.

Keywords

telomeres, Hispanic, cellular aging, acculturation, stress, pregnancy

Telomeres are an important structure for maintaining genetic stability because of their role in regulating cellular aging (Blackburn, Epel, & Lin, 2015). Telomeres are specialized nucleoprotein complexes located at the end of chromosomes that prevent genomic instability and ensure complete chromosomal replication. Telomere length (TL) normally decreases with cellular replication and thus with aging. Once a critically short length is reached, cellular senescence is triggered. Accelerated shortening of telomeres has been associated with multiple negative health outcomes across the life span, including cardiovascular disease, dementia, diabetes, and cognitive decline (Lyon, Starkweather, Montpetit, Menzies, & Jallo, 2014). Environmental factors that have been associated with accelerated TL shortening, including cigarette smoking, radiation, oxidative stress, and most recently, psychological stress exposure, including a history of early maltreatment, mood disorders, perceived stress, stress related to high-intensity caregiving, and neighborhood disorder (Geronimus et al., 2015).

In part because of recent research, TL has been touted as a promising biomarker for assessing the cumulative influence of psychosocial and environmental factors on the risk of poor health outcomes. However, the ways in which such multidimensional factors interact to affect TL have not been clearly determined. One recent study (Geronimus et al., 2015) found that there were differences by race and ethnicity in TL; specifically, poor Mexican Americans had longer TL than nonpoor Mexican Americans. Those classified as poor were primarily first-generation Mexican Americans, while those in the

[1] College of Nursing, Texas A&M Health Science Center, Bryan, TX, USA
[2] Department of Medical Physiology, Texas A&M Health Science Center, Bryan, TX, USA
[3] College of Nursing Omaha Division, The University of Nebraska Medical Center, Omaha, NE, USA
[4] College of Nursing, The Ohio State University, Columbus, OH, USA

Corresponding Author:
R. Jeanne Ruiz, PhD, College of Nursing, Texas A&M Health Science Center, 1359 TAMU, 8447 State Highway 47, Bryan, TX 77807, USA.
Email: roberta.ruiz@tamhsc.edu

nonpoor group were predominantly U.S.-born. Poor, newly immigrated Mexicans often have better health than other people living in poverty, a finding that is consistent with what has been called the "Hispanic paradox" (Markides & Eschbach, 2005), whereby health measures decline with increasing years of living in the United States. This paradox is often attributed to the process of acculturation, defined as the development of new cultural traits that occur as immigrant groups interact with those in their living environment. Geronimus et al. (2015) suggested that second and later generations of Mexican Americans may experience prejudice and stereotype more deeply than their parents and grandparents, which may activate physiological stress responses. Canales (2000) first introduced these ideas as stigmatization or "othering," which tends to emerge in second-generation immigrant groups.

Although there is a paucity of studies of the relationship between stress exposure during the prenatal period and TL, Entringer et al. (2011) found that exposure to psychosocial stress during pregnancy was linked to shorter TL in the women's offspring during adulthood, with an average of 3.5 years of additional cellular aging in adults whose mothers had experienced stress during pregnancy. Thus, it is possible that during the intrauterine period, the telomere biology system may be altered in a way that increases cellular dysfunction, aging, and susceptibility to disease later in life (Entringer, Buss, & Wadhwa, 2012). In another previous study, investigators found that telomere shortening was related to not only the occurrence but also the duration of stress induced by intimate partner violence, which presents the possibility that the effect of prenatal stress on TL may also be a function of stress chronicity (Humphreys et al., 2012). The concept of cumulative trauma (Martin, Cromer, Deprince, & Freyd, 2013) may also apply to the relationship between prenatal stress and the shortened telomere effect. In addition to effects over the life span, recent work (Ferrari, Facchinetti, Saade, & Menon, 2016) has linked placental telomere shortening with stillbirths and placental senescence, but much more investigation is needed to understand the pathways involved.

Although scant, the existing research suggests that premature cellular senescence may occur in Hispanic Mexican Americans, and this senescence may affect health outcomes. Thus, in the present study, we undertook the analysis of the relationships among cellular senescence as measured by TL, acculturation, depression, discrimination, and stress in Hispanic Mexican American women during pregnancy.

Method

Participants

We conducted this analysis as part of a larger study (hereafter referred to as the parent study) of preterm birth (PTB) in pregnant Hispanic Mexican American women. With a focus on the relationships among endocrine, immune, and psychological factors and based on a psychoneuroimmunology framework, the parent study used a cross-sectional, prospective design with a convenience sample, with data collected between 2008 and 2012. Participants were Hispanic Mexican American women who were self-pay or had Title V insurance (state funding), Medicaid, or private insurance. Inclusion criteria were as follows: the ability to read and speak English or Spanish, aged 14–40 years, carrying one fetus, self-identification as a Mexican or Hispanic Mexican American, and having lived in the United States for more than 10 years. Exclusion criteria included major medical disorders such as diabetes or chronic hypertension, psychiatric disorders identified during the pregnancy, thyroid disorders, use of steroids at the time of data collection, fetal anomalies, uterine anomalies, fetal demise, placement of a cerclage, and multiple gestations. Prior PTB was not an exclusion criterion. Data were collected at 22–24 weeks' gestation, shown in previous studies to be a critical window for the development of the neuroendocrine system in the fetus and a time when maternal stressors may significantly affect placental functioning, fetal development, and infant outcomes at birth (Ruiz, Gennaro, et al., 2015).

Recruitment took place in two obstetrical clinics and six private physician practices in central Texas and the gulf coast area. A bilingual research associate approached the participants after the provider initially introduced the study. A data collection visit occurred separately, at which time we obtained informed consent after ensuring that women met the criteria for inclusion. All participants gave written consent in Spanish or English per participant preference; women under the age of 18 years gave child assent, and we also obtained parental consent. The institutional review boards of the University of Texas Medical Branch in Galveston and the University of Texas at Austin approved the research protocol. We conducted the study in accordance with the ethical standards established in the 1964 Declaration of Helsinki.

We collected data between 2 and 4 p.m. to control for diurnal differences. The research nurse initially drew 20 ml of blood by venipuncture and placed 5 ml in a Paxgene tube for genetic analysis. We also obtained demographic data, including age, marital status, highest year of education completed, annual income, and insurance status. The research nurse administered standardized questionnaires, asking participants to use their best judgment in completing the questionnaires if they had questions.

We chose a subset of the total sample for an initial exploratory analysis of TL ($n = 56$). We chose participants based on risk profiles for PTB (Ruiz, Dwivedi, et al., 2015), selecting equal numbers from the three risk-profile groups (low, moderate, and high risk for PTB). We attempted to match from each profile those women who had a PTB (<37 weeks) to those women who had a term birth (>37 weeks) on age, gravidity, and body mass index (BMI).

Measures

Participants completed a number of research instruments including the Acculturation Rating Scale for Mexican Americans (ARSMA-II; Cuellar, Arnold, & Maldonado, 1995), the

Beck Depression Inventory (BDI-II; Beck, Steer, Ball, & Ranieri, 1996), the Experiences of Discrimination (EOD) Scale (Krieger, Smith, Naishadham, Hartman, & Barbeau, 2005), and the Perceived Stress Scale (PSS-10; Cohen, Tyrrell, & Smith, 1993). The measures were given in English or Spanish based on participant language preference. All questionnaires were translated and back translated prior to administration, and all had a coefficient α of .75–.90 in the study for both English and Spanish. For each measure, higher scores indicated higher levels of the psychosocial measure.

Acculturation. We used the ARSMA-II to measure the multidimensional aspects of acculturation (Cuellar et al., 1995). The scale assesses (a) language use and preference, (b) ethnic identity and classification, (c) cultural heritage and ethnic behaviors, and (d) ethnic interaction. The ARSMA-II has two scales with 38 total Likert-type items in Spanish and English. We used the acculturation-level continuous measure, which assesses the dynamic process of acculturation with higher scores indicating more acculturation, and the categorical measure of Anglo orientation, which assesses integration into the Anglo culture of the United States.

Depression. We measured depression using the BDI-II, a 21-item multiple-choice, Self-Inventory Depression Scale. The BDI-II measures the typical symptoms of depression including pessimism, suicide, irritability, insomnia, fatigue, and changes in appetite (Beck et al., 1996). Each item is rated on a 4-point scale ranging from 0 to 3, and the maximum possible score on the scale is 63. Common cutoffs used for levels of depression are 0–9 minimal depression, 10–18 mild depression, 19–29 moderate depression, and 30–63 severe depression (Beck, Steer, & Garbin, 1988). Investigators have previously tested the BDI in pregnant populations to screen for depression (Alexander, de la Fey Rodriguez Munoz, Perry, & Le, 2014; Pereira et al., 2014)

Discrimination. We measured the frequency of EOD using the EOD Scale (Krieger et al., 2005). The EOD measures whether a person has experienced discrimination in nine different situations as well as whether they believe they have received unfair treatment because of their race or ethnicity. The originators of the scale found it to be both valid and reliable among Hispanics, with a Cronbach's α of .74. We assigned a value of 0 to reports of no discrimination, 1 to one report, 2.5 to two to three reports, and 5 to four reports. The sum of these values provided a total EOD frequency. A higher score indicated a higher frequency of EOD and/or unfair treatment because of ethnicity.

Stress. We used the PSS-10 to measure perceived stress. The PSS-10 surveys the degree to which the respondent finds his or her life to be unpredictable, uncontrollable, and overwhelming using a 5-point Likert-type scale (Cohen, Kamarck, & Mermelstein, 1983). The questions are general and applicable to a broad population. Researchers have used it many times in pregnancy and with ethnically diverse samples (Hoffman, Mazzoni, Wagner, Laudenslager, & Ross, 2016; Jallo et al., 2015).

BMI. To calculate BMI, we used the prepregnancy weight as recorded on the prenatal chart and the height as measured on the scale at the physicians' offices or clinics at the data collection visit. We used the following formula: $\text{BMI} = \text{weight in pounds} \times 703/\text{height in inches}$.

Education. We collected data on education by asking a simple question as to the highest level in years of school that the participants had attended.

Income. We asked participants to report their annual personal income.

TL. We measured TL from peripheral blood mononuclear cells. Frozen samples were thawed at 37°F and mixed with 9 ml red blood cell (RBC) lysis buffer. The cells were degraded with RNase A. Proteins were precipitated and the results transferred to a fresh tube where DNA was precipitated with isopropanol and then washed with 70% ethyl alcohol. DNA was then resuspended in DNA hydration solution. Following isolation of the DNA and assessment of DNA integrity, monochrome multiplex quantitative telomere PCR was used to determine TL (Cawthon, 2009).

Data Analysis

Data were analyzed descriptively, and development and testing of a structural equation model was performed with MPlus software (Version 6.11, Muthén and Muthén; www.StatModel.com). Stata for Windows (Version 14, StataCorp LP; www.stata.com) was used for constructing the diagram of the model solution.

Results

We detail demographic and other relevant characteristics of the participants in the parent study and subsample chosen for telomere analysis in Table 1. There were no significant differences in corresponding means or proportions between the parent sample and subsample. In Table 2, we show relationships among primary variables of interest in the analysis. TL was significantly inversely correlated with Anglo orientation, with shorter telomeres being associated with greater Anglo orientation. We found a similar, though not significant, trend in the relationship between TL and acculturation level, with shorter telomeres associated with increased acculturation. Anglo orientation and acculturation level were significantly correlated with each other and with depression, and Anglo orientation approached significant correlation with both discrimination and perceived stress. Depression, discrimination, and stress were all significantly correlated. TL was not correlated with BMI, education, or income. Education was moderately correlated with Anglo orientation, income, and discrimination. BMI had a small correlation with acculturation level.

Table 1. Demographics and Related Statistics for Participants of the Parent Study and the Subsample for the Telomere Study.

	Telomere Study	
Variable	Subsample $n = 56$	Parent Study $N = 516$
Age, years	24.9 [23.6, 26.1]	24.6 [24.1, 25.1]
14–17	0 (0)	55 (10.7)
18–25	35 (62.5)	256 (49.6)
26–43	21 (37.5)	203 (39.3)
Not reported	—	2 (0.4)
Marital status		
Unmarried	26 (46.4)	275 (53.3)
Married	30 (53.6)	240 (46.5)
Not reported	—	1 (0.2)
Education		
Less than high school	15 (26.8)	180 (34.9)
High school or more	41 (73.2)	331 (64.1)
Not reported	—	5 (1.0)
Annual personal income, US$	US$30,312 [US$21,749, US$38,875]	US$28,706 [US$26,569, US$30,843]
Less than US$25K	26 (46.4)	246 (47.7)
US$25K or more	24 (42.9)	210 (40.7)
Not reported	6 (10.7)	60 (11.6)
Country of birth		
United States	30 (53.6)	298 (57.7)
Non-United States	26 (46.4)	217 (42.1)
Not reported	—	1 (0.2)
Number of years in the United States	20.8 [19.1, 22.4]	20.4 [19.8, 21.0]
0–10	4 (7.1)	52 (10.1)
11 or more	52 (92.9)	463 (89.7)
Not reported	—	1 (0.2)
Generational status (see "Method" for description)		
First generation	24 (42.8)	163 (31.6)
Second generation	15 (26.8)	166 (32.2)
Third or higher generation	15 (26.8)	169 (32.7)
Not reported	2 (3.6)	18 (3.5)
Ethnicity		
Mexican American	31 (55.4)	293 (56.8)
Mexican	19 (33.9)	144 (27.9)
Puerto Rican	0 (0)	1 (0.2)
Hispanic	5 (8.9)	73 (14.1)
Other	1 (1.8)	2 (0.4)
Not reported	—	3 (0.6)
Acculturation level (ARSMA II score)	−0.27 [−3.03, 2.20]	−0.24 [−4.00, 3.24]
BDI total score	11.7 [9.5, 13.9]	10.6 [9.9, 11.2]
EOD score	5.7 [3.3, 8.1]	4.9 [4.3, 5.5]
PSS score	16.2 [14.6, 17.8]	16.5 [16.0, 17.0]

Note. Data are reported as mean [95% CI] or as *n* (%). ARSMA = Acculturation Rating Scale for Mexican Americans; BDI = Beck Depression Inventory; EOD = Experiences of Discrimination; PSS = Perceived Stress Scale.

Structural Equation Model

Preliminary factor analysis of the variables indicated that two latent factors accounted for more than 70% of the variance in TL, with Anglo orientation and acculturation level loading on one factor and total scores for depression, discrimination, and perceived stress loading on the other. Based on the observed pattern of associations with the measures, we labeled the latent factors (constructs) acculturation and negative affectivity, respectively. Figure 1 shows the structural equation model. Goodness-of-fit statistics were all consistent with an extremely well-fitting model (Table 3).

Both Anglo orientation and acculturation level were strong indicators of the acculturation construct. Depression and perceived stress were strong indicators of negative affectivity, while discrimination was more weakly associated with this construct. Acculturation and negative affectivity each weakly influenced the other: Higher acculturation tended to influence negative affectivity, while negative affectivity influenced acculturation. As depicted in the model, acculturation had a

Table 2. Sample (Pearson) Correlations and Significance Values.

	Anglo Orientation (p)	Acculturation Level (p)	BMI (p)	Depression (p)	Discrimination (p)	Education (p)	Income (p)	Stress (p)	Telomere Length (p)
Anglo Orientation[a]	1.000								
Acculturation Level[b]	.839 (<.001)	1.000							
BMI	.088 (.048)	.123 (.005)	1.000						
Depression[c]	.120 (.007)	.123 (.005)	.012 (.779)	1.000					
Discrimination[d]	.077 (.081)	.056 (.207)	.121 (.006)	.217 (<.001)	1.000				
Education[e]	.260 (< .001)	.164 (<.001)	.056 (.210)	.0178 (.690)	.103 (.020)	1.000			
Income[f]	.044 (.355)	−.054 (.2464)	−.054 (.246)	−.084 (.074)	.019 (.694)	.170 (<.001)	1.000		
Stress[g]	.076 (.085)	.062 (.165)	.044 (.323)	.561 (<.001)	.167 (<.001)	−.067 (.134)	−.150 (.001)	1.000	
Telomere length	−.275 (.042)	−.243 (.074)	.200 (.139)	.118 (.387)	.213 (.116)	−.184 (.175)	.055 (.706)	.140 (.303)	1.000

Note. BMI = body mass index.
[a]Anglo orientation was measured with the Anglo Orientation Subscale of the Acculturation Rating Scale for Mexican Americans. [b]Acculturation level was measured with the Acculturation Subscale of the Acculturation Rating Scale for Mexican Americans. [c]Depression was measured with the Beck Depression Inventory (total score). [d]Discrimination was measured with the Experiences of Discrimination Scale. [e]Education was measured by number of years in school. [f]Income was measured by self-report of personal annual amount received in dollars. [g]Stress was measured with the Perceived Stress Scale (total score).

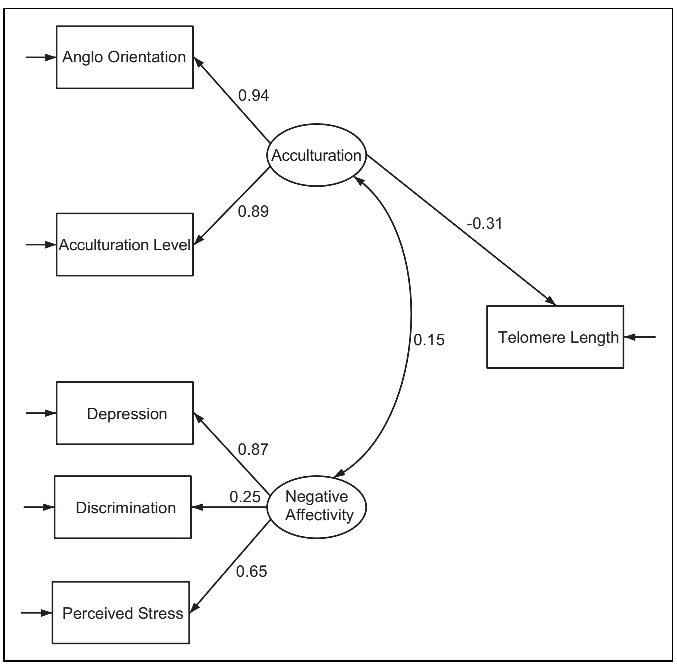

Figure 1. Structural equation Model A of the interaction between acculturation and negative affectivity and the effects of acculturation on telomere length. Ovals represent latent constructs and rectangles depict measured indicators. Straight lines represent directional relationships and curved lines nondirectional correlative relationships. Relative strengths of the (standardized) regression or covariance relationships are represented by the numbers next to each line. All correlations shown are significant at $p < .05$.

Table 3. Goodness-of-Fit Indices for Structural Equation Model A.

Index	Abbreviation	Value	Criteria for Acceptable Fit
Comparative fit index	CFI	1.000	≥0.95
Tucker–Lewis index (nonnormed)	TLI	1.007	≥0.95
Standardized root mean square residual	SRMR	0.036	≤0.08
Root mean square error of approximation (RMSEA)	RMSEA	<0.001	≤0.06
90% confidence interval around RMSEA	90% CI	[0.000, 0.035]	Upper bound < 0.08
p Value for H_0: RMSEA $\leq$ .05	p_{CLOSE}	.991	>.05
Chi-square test of model fit (p value)	$p\chi^2$	.779	>.05

significant negative effect on TL, while negative affectivity had a smaller indirect negative effect on TL (−0.05), calculated as the product of the path coefficient of 0.15 (from negative affectivity's association with acculturation) and −0.31 (for acculturation's effect on TL). Figure 2 depicts a comparison of the relative influences of the five measured indicators on telomere shortening.

Figure 3 shows the addition of education and BMI to the latent construct of acculturation. We could not test income, as there were too many missing values among the subsample with the telomere measurements, causing an error of the covariance coverage being below the lower limit. We tested education with the acculturation measures based on the correlations. Attempts to test BMI with the other indicators of negative affect resulted in model misspecification errors. Testing BMI as a direct predictor of TL in the model converged without error but resulted in an even worse fit than that for Model B. Moreover, the coefficient for BMI as a direct predictor of TL in that model was not significant. Although Model B still meets the criteria

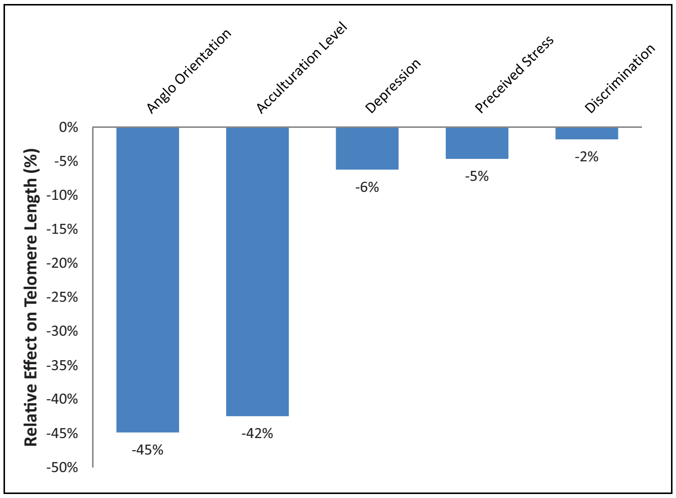

Figure 2. Relative indirect influences of the indicators of acculturation and negative affectivity on telomere length.

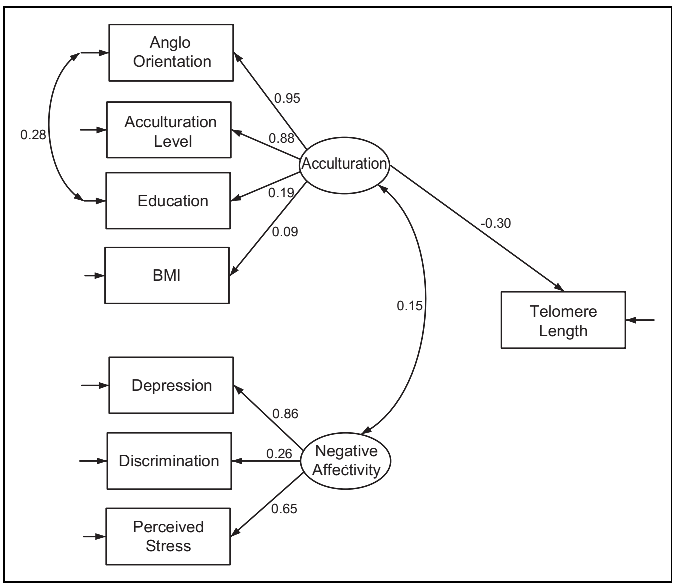

Figure 3. Structural equation Model B of the interaction between acculturation, including body mass index and education, negative affectivity, and the effects of acculturation on telomere length. Ovals represent latent constructs and rectangles depict measured indicators. Straight lines represent directional relationships and curved lines represent nondirectional correlative relationships. Relative strengths of the (standardized) regression or covariance relationships are represented by the numbers next to each line. All correlations shown are significant.

for a good fit as shown in Table 4, test of the change in the χ^2 for the models indicated that Model A provided a significantly better fit to the data.

Table 4. Goodness-of-Fit Indices for Structural Equation Model B, With Body Mass Index (BMI) and Education.

Index	Abbreviation	Value	Criteria for Acceptable Fit
Comparative fit index	CFI	0.992	≥0.95
Tucker–Lewis index (nonnormed)	TLI	0.987	≥0.95
Standardized root mean square residual	SRMR	0.080	≤0.08
Root mean square error of approximation (RMSEA)	RMSEA	0.029	≤0.06
90% confidence interval around RMSEA	90% CI	[0.000, 0.035]	Upper bound < 0.08
p Value for H_0: RMSEA ≤ .05	p_{CLOSE}	.931	>.05
Chi-square test of model fit (p value)	$p\chi^2$	.110	>.05

Discussion

Ours is the first study to examine relationships among measures of Anglo orientation, acculturation, depression, perceived stress, discrimination, and TL in pregnant Mexican or Mexican American women living in the United States. Relationships we identified between the variables suggest that Anglo orientation and acculturation are negatively associated with TL. Depression, perceived stress, and discrimination are all related and positively associated with Anglo orientation and acculturation, suggesting that increased psychological stress is related to Anglo orientation and acculturation, which previous researchers have also observed (D'Anna-Hernandez, Aleman, & Flores, 2015). Results of a more sophisticated analysis of the variables revealed strong relationships between the latent variables of acculturation and negative affectivity and shortened TL. Our findings suggest that pregnant Hispanic Mexican American women who were more acculturated had shortened telomeres compared to newly immigrated pregnant Hispanic Mexican American women, with negative affectivity having an indirect effect on TL through mediation by acculturation.

Further research is needed to confirm the results of this analysis and to explore the potential effects of psychological and physiological factors on the health and well-being of Hispanic Mexican Americans. The present research supports previous results that have identified adverse effects of higher levels of acculturation on health and well-being in this population (D'Anna-Hernandez et al., 2015; Geronimus et al., 2015; Markides & Eschbach, 2005; Viruell-Fuentes, 2007). Geronimus et al. (2015) reported similar associations between acculturation and TL in the Mexican American population. Their discussion emphasized the role of situational stress and the complexity of psychosocial situations and their effect on physiological mechanisms. Our analyses examined varying acculturation levels among pregnant Mexican American women and identified negative psychological and biological effects with higher levels of Anglo orientation and acculturation. These findings suggest that the change in health and wellness seen with acculturation as part of the "Hispanic paradox" (Markides & Eschbach, 2005) may be related to marginalization and othering, as Canales suggested (2000). It remains unclear as to what the mediating situational factors are that may be influencing psychological and subsequent physiologic stress.

Although negative affectivity was not directly related to shortened TL in the present study, the mediated relationship with the latent variable of acculturation suggests the important role psychological stress plays in determining TL. Negative affectivity, a construct comprised of depression, perceived stress, and discrimination in our analysis, may enhance a young immigrant's desire for greater acculturation to mitigate the negative emotional effects that can result from identification with a marginalized ethnic group. The potential health implications, however, of "trying to fit in" by adopting the cultural ways and habits of the immigrant's new country, as illustrated in this analysis, can have potentially serious consequences. Certainly, the relationship between acculturation and shortened TL seen in this subsample is alarming and not only for the women who experience this phenomenon. Entringer and colleagues' (2011) finding that shortened TL in pregnant women was linked to shortened TL in their offspring suggests the potential inheritance of genetic alterations that may affect later generations of immigrant populations. Similarly, a recently published theoretical framework (Fox, Entringer, Buss, DeHaene, & Wadhwa, 2015) suggests that acculturation in Mexican American pregnant women has negative effects on fetal programming, thus exposing the generational impact of this phenomenon.

Although questions remain about the implications of TL during pregnancy, it may be helpful for those who provide care to this at-risk group to consider providing support for psychological well-being. For example, offering support groups for Mexican American pregnant women at their health-care providers or within the community may mitigate some of the effects associated with depression, discrimination, and stress. Certainly, increased awareness on the part of clinicians who work with Hispanic Mexican American women could be helpful. D'Anna-Hernandez and colleagues (2015) suggest that clinicians pay particular attention to acculturative stress during obstetric care of Mexican American pregnant women, specifically as it relates to maternal depression.

One limitation of our study is that we were unable to capture all of the components of negative affectivity and psychosocial stress in this population. We were able to measure depression, perceived stress, and discrimination; however, the association between these variables and acculturation was statistically significant but relatively weak, suggesting that we have yet to identify the major psychosocial stressor affecting physiologic stress and subsequent TL. More qualitative analyses may be necessary to identify the predictive concepts related to the negative affectivity found in this and other studies. Another limitation of the analysis is that, because it was not a primary aim of the parent study, the analysis may not have been powered sufficiently. The analysis was exploratory, and we recommend similar testing in future work with a larger sample size.

In summary, our analyses showed relationships between psychosocial measures of stress and TL. Mexican American pregnant women with higher levels of Anglo orientation and acculturation had shortened TL and higher levels of psychological stress, including depression, perceived stress, and discrimination. Our findings, as well as previous findings, emphasize the importance of focusing intervention strategies on this specific population. Future research should continue to explore the accumulating psychological stress associated with greater acculturation and its potential harm to women and their children.

Acknowledgments

The authors appreciate the work of Dr. Rachid Drissi at Cincinnati Children's Hospital Medical Center for his analysis of lab samples for TL.

Author Contribution

R. J. Ruiz contributed to conception, design, data acquisition, analysis, and interpretation; drafted and critically revised the manuscript; gave final approval; and agrees to be held accountable for all aspects of work, ensuring integrity and accuracy. J. Trzeciakowski contributed to design, data analysis, and interpretation; drafted and critically revised the manuscript; gave final approval; and agrees to be held accountable for all aspects of work, ensuring integrity and accuracy. T. Moore contributed to design and data interpretation, drafted the manuscript, gave final approval, and agrees to be held accountable for all aspects of work, ensuring integrity and accuracy. K. Ayers contributed to conception, design, data analysis, and interpretation; drafted and critically revised the manuscript; gave final approval; and agrees to be held accountable for all aspects of work, ensuring integrity and accuracy. R. Pickler contributed to conception, design, data acquisition, analysis, and interpretation; drafted and critically revised the manuscript; gave final approval; and agrees to be held accountable for all aspects of work, ensuring integrity and accuracy.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: National Institute of Nursing Research Grant number R01017891.

References

Alexander, L. A., de la Fey Rodriguez Munoz, M., Perry, D. F., & Le, H. N. (2014). The latent symptom structure of the Beck Depression Inventory: Second edition in Latina pregnant women. *Maternal Child Health Journal*, *18*, 1132–1141. doi:10.1007/s10995-013-1343-5

Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. (1996). Comparison of Beck Depression Inventories-IA and -II in psychiatric outpatients. *Journal of Personality Assessment*, *67*, 588–597.

Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*, *8*, 77–100.

Blackburn, E. H., Epel, E. S., & Lin, J. (2015). Human telomere biology: A contributory and interactive factor in aging, disease risks, and protection. *Science*, *350*, 1193–1198. doi:10.1126/science.aab3389

Canales, M. K. (2000). Othering: Toward an understanding of difference. *ANS: Advances in Nursing Science*, *22*, 16–31.

Cawthon, R. M. (2009). Telomere length measurement by a novel monochrome multiplex quantitative PCR method. *Nucleic Acids Research*, *37*, e21. doi:10.1093/nar/gkn1027

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*, 385–396.

Cohen, S., Tyrrell, D. A., & Smith, A. P. (1993). Negative life events, perceived stress, negative affect, and susceptibility to the common cold. *Journal of Personality and Social Psychology*, *64*, 131–140.

Cuellar, I., Arnold, B., & Maldonado, R. (1995). Acculturation rating scale for Mexican Americans-II: A revision of the original ARSMA scale. *Hispanic Journal of Behavioral Sciences*, *17*, 275–304. doi:10.1177/07399863950173001

D'Anna-Hernandez, K. L., Aleman, B., & Flores, A. M. (2015). Acculturative stress negatively impacts maternal depressive symptoms in Mexican-American women during pregnancy. *Journal of Affective Disorders*, *176*, 35–42. doi:10.1016/j.jad.2015.01.036

Entringer, S., Buss, C., & Wadhwa, P. D. (2012). Prenatal stress, telomere biology, and fetal programming of health and disease risk. *Science Signaling*, *5*, pt 12. doi:10.1126/scisignal.2003580

Entringer, S., Epel, E. S., Kumsta, R., Lin, J., Hellhammer, D. H., Blackburn, E. H., . . . Wadhwa, P. D. (2011). Stress exposure in intrauterine life is associated with shorter telomere length in young adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *108*, E513–E518. doi:10.1073/pnas.1107759108

Ferrari, F., Facchinetti, F., Saade, G., & Menon, R. (2016). Placental telomere shortening in stillbirth: A sign of premature senescence? *Journal of Maternal-Fetal & Neonatal Medicine*, *29*, 1283–1288. doi:10.3109/14767058.2015.1046045

Fox, M., Entringer, S., Buss, C., DeHaene, J., & Wadhwa, P. D. (2015). Intergenerational transmission of the effects of acculturation on health in Hispanic Americans: A fetal programming perspective. *American Journal of Public Health*, *105*, S409–S423. doi:10.2105/AJPH.2015.302571

Geronimus, A. T., Pearson, J. A., Linnenbringer, E., Schulz, A. J., Reyes, A. G., Epel, E. S., . . . Blackburn, E. H. (2015). Race-ethnicity, poverty, urban stressors, and telomere length in a Detroit community-based sample. *Journal of Health and Social Behavior*, *56*, 199–224. doi:10.1177/0022146515582100

Hoffman, M. C., Mazzoni, S. E., Wagner, B. D., Laudenslager, M. L., & Ross, R. G. (2016). Measures of maternal stress and mood in relation to preterm birth. *Obstetrics and Gynecology*, *127*, 545–552. doi:10.1097/AOG.0000000000001287

Humphreys, J., Epel, E. S., Cooper, B. A., Lin, J., Blackburn, E. H., & Lee, K. A. (2012). Telomere shortening in formerly abused and never abused women. *Biological Research for Nursing*, *14*, 115–123. doi:10.1177/1099800411398479

Jallo, N., Elswick, R. K., Kinser, P., Masho, S., Price, S. K., & Svikis, D. S. Jr. (2015). Prevalence and predictors of depressive symptoms in pregnant African American women. *Issues in Mental Health Nursing*, *36*, 860–869. doi:10.3109/01612840.2015.1048014

Krieger, N., Smith, K., Naishadham, D., Hartman, C., & Barbeau, E. M. (2005). Experiences of discrimination: Validity and reliability of a self-report measure for population health research on racism and health. *Social Science and Medicine*, *61*, 1576–1596. doi:10.1016/j.socscimed.2005.03.006

Lyon, D. E., Starkweather, A. R., Montpetit, A., Menzies, V., & Jallo, N. (2014). A biobehavioral perspective on telomere length and the exposome. *Biological Research for Nursing*, *16*, 448–455. doi:10.1177/1099800414522689

Markides, K. S., & Eschbach, K. (2005). Aging, migration, and mortality: Current status of research on the Hispanic paradox. *Journals of Gerontology. Series B: Psychological Sciences and Social Sciences*, *60*, 68–75.

Martin, C. G., Cromer, L. D., Deprince, A. P., & Freyd, J. J. (2013). The role of cumulative trauma, betrayal, and appraisals in understanding trauma symptomatology. *Psychological Trauma*, *52*, 110–118. doi:10.1037/a0025686

Pereira, A. T., Marques, M., Soares, M. J., Maia, B. R., Bos, S., Valente, J., . . . Macedo, A. (2014). Profile of depressive symptoms in women in the perinatal and outside the perinatal period: Similar or not? *Journal of Affective Disorders*, *166*, 71–78.

Ruiz, R. J., Dwivedi, A. K., Mallawaarachichi, I., Balcazar, H. G., Stowe, R. P., Ayers, K. S., & Pickler, R. (2015). Psychological, cultural and neuroendocrine profiles of risk for preterm birth. *BMC Pregnancy Childbirth*, *15*, 204. doi:10.1186/s12884-015-0640-y

Ruiz, R. J., Gennaro, S., O'Connor, C., Marti, C. N., Lulloff, A., Keshinover, T., . . . Melnyk, B. (2015). Measuring coping in pregnant minority women. *Western Journal of Nursing Research*, *37*, 257–275. doi:10.1177/0193945914527176

Viruell-Fuentes, E. A. (2007). Beyond acculturation: Immigration, discrimination, and health research among Mexicans in the United States. *Social Science and Medicine*, *65*, 1524–1535. doi:10.1016/j.socscimed.2007.05.010