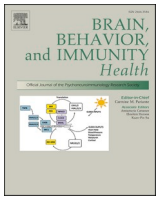
Brain, Behavior, & Immunity - Health 43 (2025) 100914

Contents lists available at ScienceDirect

Brain, Behavior, & Immunity - Health

journal homepage: www.editorialmanager.com/bbih/default.aspx



Prenatal inflammation and trauma symptoms in Latina mothers: The role of discrimination and growing up in an ethnic minoritized context

Rebeca Alvarado-Harris [a,**], Krista Perreira [b], Cheryl L. Woods-Giscombe [a], William Roger Mills-Koonce [c], Hudson P. Santos Jr. [d,*]

[a] School of Nursing, University of North Carolina at Chapel Hill, North Carolina, United States
[b] Department of Social Medicine, University of North Carolina at Chapel Hill, North Carolina, United States
[c] School of Education, University of North Carolina at Chapel Hill, North Carolina, United States
[d] The University of Miami School of Nursing and Health Studies, Florida, United States

ARTICLE INFO

Keywords:
Hispanic or Latino
Trauma
Inflammation
Discrimination
Pregnancy
Immigrant

ABSTRACT

Background: The race-based traumatic stress model proposes that discrimination elicits trauma-related symptoms. Cumulative discriminatory experiences and subsequent trauma symptoms may lead to prenatal inflammation, with far reaching consequences for the health of a mother and her child.
Methods: Latina mothers, primarily of Mexican and Central American heritage ($n = 150$), completed the Everyday Discrimination Scale and the Traumatic Avoidance subscale of the Inventory of Depression and Anxiety Symptoms-II during pregnancy (24–32 weeks). Plasma levels of cytokines were measured with multiplex assays, which were aggregated into a pro-inflammatory cytokine profile (IL-1β, TNF-α, IFN-γ, and IL-8) after a Confirmatory Factor Analysis supported this approach.
Results: Latina mothers who grew up in the US reported more discrimination, more traumatic avoidance symptoms, and had a more elevated cytokine profile than those who immigrated after childhood. Based on a two-mediator sequential model, discrimination and traumatic avoidance symptoms sequentially provided mechanistic support for the higher levels of cytokines observed in mothers who grew up in the US. Additionally, mothers who experienced trauma symptoms in response to discrimination had an elevated cytokine profile, whereas those who did not had a suppressed cytokine profile.
Conclusion: This is among the first studies to examine the association between trauma symptoms, discrimination, and inflammation during pregnancy. In so doing, it elucidates critical pathways by which discrimination may be differentially biologically embedded across immigrant generations. Emotional responses to and chronicity of discrimination may be critical factors for understanding how experiences of discrimination may influence the maternal inflammatory milieu.

Immigrant mothers, primarily of Mexican descent, generally achieve healthy birth outcomes upon initial immigration to the United States (US) (Page, 2004). Yet this advantage dissipates with longer length of residency in the US and into the next generation (McGlade et al., 2004). Among women who have grown up in an ethnic minoritized context, experiences of discrimination may become psychologically and biologically embedded over time. Longer length of US residency and US nativity have been associated with greater immune activation (e.g., inflammation) in women during pregnancy (Ruiz et al., 2007; Scholaske et al., 2018), a sensitive period of heightened immune plasticity for mother and child. Prenatal inflammation may provide biological explanations for the etiological roots of early childhood conditions that increase across post-migration generations, such as low birth weight (Page, 2004; Cobas et al., 1996; de la Rosa, 2002), chronic childhood diseases (e.g., asthma) (Padilla et al., 2009; Hillemeier et al., 2015), and socioemotional difficulties (Harris et al., 2020; Breslau et al., 2011; García Coll and Marks). Psychosocial mechanisms, including those related to discrimination, may initiate or perpetuate a trajectory of worsened maternal and child health. The race-based traumatic stress model proposes that discrimination elicits trauma-related symptoms

* Corresponding author. University of North Carolina at Chapel Hill, North Carolina, United States.
** Corresponding author.
E-mail address: rebeca@email.unc.edu (H.P. Santos).

https://doi.org/10.1016/j.bbih.2024.100914
Received 24 July 2024; Received in revised form 22 November 2024; Accepted 23 November 2024
Available online 24 November 2024

(Carter, 2007). In turn, cumulative discriminatory experiences and subsequent trauma symptoms may lead to prenatal inflammation, with far reaching intergenerational consequences for the health of a mother and her child (Fig. 1) (Christian, 2019).

1. Discrimination, ethnic minoritized context, and trauma symptoms

Interpersonal discrimination refers to treatment that limits "opportunities, resources, power, and well-being of individuals and populations" based on membership to a social group, including ethnicity, race, and immigration status (Structural racism and discrimination, 2023). The positive relationship between longer length of US residency and self-reported discrimination has remained suprisingly consistent. US nativity, younger age at migration, and increased English language proficiency have been associated with increased self-reported discrimination (Santana, 2018; Pérez et al., 2008; Cook et al., 2009; Flippen et al., 2015). Ethnic minoritization (i.e., societal process of devaluing a socially constructed group) in childhood may influence how discrimination may become psychologically and biologically embedded across the life course and into the next generation. For instance, in a 20-year longitudinal study, Puerto Rican youth who grew up in South Bronx, New York reported more discrimination and experienced more psychological distress as adults than their counterparts who grew up in similarly disadvantaged neighborhoods in Puerto Rico (Alegria et al., 2019). These findings are echoed in qualitative research in which Mexican American women who grew up in the US experienced "an implicit sense of stigmatized difference," beginning in early childhood (Viruell-Fuentes, 2007).

Given the established link between psychological functioning and discrimination, growing up in an ethnic minoritized context may contribute to worsened emotional health (Cook et al., 2009; Alegria et al., 2019; Falgas-Bague et al., 2023). For instance, US-born Latinas and foreign-born Latinas who immigrated to the US during childhood (0–12 years old) may be more likely to attempt suicide than those who immigrated later in life (Bersani et al., 2020). Similarly, Latinas who were born in the US or immigrated during early childhood (0–6 years old) may be more likely to develop anxiety and substance abuse disorders than those who immigrated in adulthood (Alegria et al., 2007). US nativity has also been linked to elevated perinatal depressive symptoms in women of Mexican heritage (Davila et al., 2009; Sumner et al., 2011). However, not all studies have shown a significant relationship between US nativity and/or early childhood migration (0–7 years old) and worsened maternal mental health (Ponting et al., 2020). Varying early life socopolitical and sociocultural contexts may also influence these relationships. For instance, experiences of discrimination may differ in newer immigrant destinations in the Southeastern US, such as the North Carolina, compared to more traditional gateways for Latin America-US migration, such as California (Flippen et al., 2015).

Despite the well-established relationship between interpersonal discrimination and worsened mental health, the specific psychological symptoms that may develop in response to emotional threats against one's sense of self remains an emerging area of inquiry (Carter, 2007). The race-based traumatic stress model posits that psychological responses to discrimination resemble the core symptoms of post-traumatic stress disorder (PTSD), primarily *intrusion* (e.g., reexperiencing), *arousal* (e.g., hyperactivity or vigilance), and *avoidance* (e.g., avoiding distressing memories) (Carter, 2007). Discrimination may also be more likely to elicit trauma-related symptoms than general psychosocial stress because it is more likely to be psychologically threatening, uncontrollable, and reoccuring (Carter, 2007). Indeed, exposure to discrimination has predicted PTSD symptoms in Mexican American youth over time (Flores et al., 2010). Furthermore, Latina women may report higher levels of trauma symptoms in response to discrimination than men (Brabeck et al., 2022), potentially due to gender role socialization processes that shape women's schemas of self-blame and responsibility (Street et al., 2018).

2. Trauma symptoms and pro-inflammatory cytokines during pregnancy

From conception to birth, the immunoregulatory role of immune cells and cytokine signaling pathways are necessary for a healthy pregnancy (Meyyazhagan et al.; Yockey and Iwasaki, 2018). Yet, emotional threats against one's sense of self (Slavich, 2020) and trauma symptoms may disrupt the tightly coordinated balance between a pro- and anti-inflammatory uterine environment. Meta-analyses in nonpregnant individuals indicate that PTSD symptoms are associated with elevated levels of pro-inflammatory cytokines, particularly IL-1β and IFN-γ (Katrinli et al., 2022; Yuan et al., 2019). In contrast, depressive symptoms may be linked to *either* immune activation (i.e., inflammation) or suppression depending on specific symptomatology and early

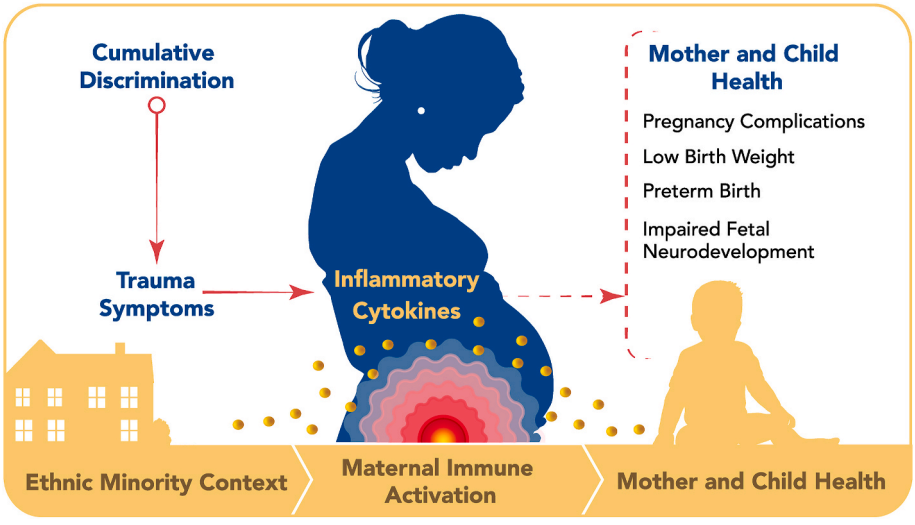


Fig. 1. Role of cumulative postmigration discrimination in the etiology of maternal and child health dispartities
Notes. Cumulative discriminatory experiences contribute to trauma symptoms, which, in turn, are associated with immune activation at the maternal-fetal interface. The resulting inflammatory cytokines may lead to worsened health outcomes for mother and child. Dashed lines indicate potential effects of maternal inflammation on mother and child health outcomes, which are not examined in this study.

life experiences (Yuan et al., 2019; Beurel et al., 2020). Similarly, a life-time history of traumatic experiences, rather than concurrent depressive or anxiety symptoms, have been associated with inflammation during pregnancy (Blackmore et al., 2011). A pro-inflammatory phenotype may underlie adverse outcomes for both mother and child ranging from pregnancy complications (e.g., recurrent pregnancy loss, preeclampsia, premature labor) (Yockey and Iwasaki, 2018) to impaired fetal neurodevelopment (Han et al., 2021). As such, cumulative racial discrimination towards another minoritized group, African American families, has been implicated as a key contributor of long-standing maternal and child health disparities (Larrabee Sonderlund et al., 2021). Among Latinas, early life exposure to a societal structure that disadvantages minoritized populations may initiate a trajectory of worsened maternal and child health. In this way, a discrimination-induced pro-inflammatory phenotype may underlie both established health disparities in African American families and emerging health disparities among later immigrant Latino generations in the US.

Cytokines associated with trauma symptoms have been identified as key immune regulators, whose dysregulated levels may disrupt pregnancy progression and fetal neurodevelopment (Christian, 2012; Hantsoo et al., 2019). For instance, IL-1β regulates implantation during the early stages of pregnancy and mediates contractions during labor (Meyyazhagan et al.). Dysregulated levels of IL-1β during pregnancy, however, have been associated with preterm labor (Yockey and Iwasaki, 2018) and increased prenatal psychosocial stress (Coussons-Read et al., 2007). Similarly, IL-8 is responsible for on-time delivery but is dysregulated in pregnant women experiencing pre-eclampsia, chronic psychosocial stress (Gillespie et al., 2021), and interpersonal violence (Saadat et al., 2022). Elevated levels of IFN-γ disrupt fetal neurodevelopment in mouse models (Yockey and Iwasaki, 2018) and interact synergistically with IL-1β and TNF-α in cytokine signaling cascades (Schroder et al., 2004). TNF-α is broad spectrum immune regulator whose orchestrated levels rise and fall in response to the needs of pregnancy. Dysregulated levels during pregnancy, however, have been associated with a lifetime history of intimate partner violence and trauma (Blackmore et al., 2011) and pregnancy complications (Yockey and Iwasaki, 2018).

Although cytokines' distinct roles are often studied individually, they function in dynamic inhibiting, activating, and synergistic networks. In particular, the transcription factor Nuclear factor-κB (NF- κB) initiates signaling cascades across numerous genes that regulate inflammation, and its critical regulatory functions have been well-described in obstetric (Gómez-Chávez et al., 2021) and psychiatric studies (Altinoz et al., 2018). Therefore, this study will integrate an aggregated cytokine profile from key pro-inflammatory cytokines that are co-expressed through NF- κB signaling cascades.

3. Present study

In the present study, we first examined relationships among growing up in the US, trauma symptoms, discrimination, and an aggregated cytokine profile. Second, we explored pathways by which growing up in the US (vs Latin America) may be related to the cytokine profile through the following research questions: (1) In the first pathway, does discrimination indirectly influence the relationship between growing up in the US and trauma symptoms? (2) In the second pathway, does discrimination indirectly influence the relationship between growing up in the US and an elevated cytokine profile? (3) Finally, do discrimination and trauma symptoms sequentially influence the relationship between growing up in the US and an elevated cytokine profile?

4. Methods

4.1. Data collection

Trained bilingual (Spanish/English) research assistants assessed mothers for eligibility during routine prenatal visits at the health department. Women who demonstrated interest in the study were given information about the study. Enrollment was coordinated with the healthcare providers of the maternity clinics and took place before or after the prenatal care visit. A research assistant collected data in English or Spanish via structured questionnaires, depending on participant's preference, at the prenatal (24–32-weeks' gestation) and 4–6 weeks postpartum visits. All measures used in this study were collected at the prenatal visit. The Institutional Review Board (IRB) approved this study, and all participants provided written consent. Full details on recruitment procedures have been previously described (Santos et al., 2018).

4.2. Participants

Healthy Latina women ($n = 150$) participated in a study to evaluate the association between discrimination exposure and psychological distress, as previously described (Santos et al., 2018). Participants were recruited from maternity clinics in a county health department in North Carolina (a newer immigrant vs a traditional gateway destination) between May 2016 and March 2017. Inclusion criteria included: (1) 18–45 years old, (2) Spanish- or English-speaking, (3) carrying a singleton pregnancy, (4) available for follow-up at 6 weeks postpartum. Exclusion criteria were: (1) currently experiencing severe depressive symptoms as determined by a psychiatric interview conducted by a psychiatrist who was a member of the research team; (2) history of psychotic or bipolar disorder or receiving psychotropic therapy (including medication such as selective serotonin reuptake inhibitors); (3) substance dependence in the last two years; (4) fetal anomaly; or (5) life-threatening conditions. Exclusion criteria were chosen to minimize confounders and control for severe mood symptoms prior to the study time frame.

The mean age of the participants was 27.7 years ($SD = 6.4$). Most participants were foreign-born (85%), reported an income of less than $30,000 a year (90%), and were married or living with a partner (77%). Participants were predominantly of Mexican (56%), Honduran (17%), and El Salvadorian (13%) heritage. In the sample, 24% of participants grew up in the US (US-born or immigration in childhood [ages 0–9]). Among these, 75% completed the survey in English. See Supplemental Table 1 for details on language choice, capacity, and frequency. Sample demographics are presented in Table 1 by whether the participant grew up in the US or Latin America.

5. Measures

5.1. Childhood in US

Two dummy predictors were used to indicate participants' upbringing location based on nativity, age at migration, and years living in the US. Five or ten-year age groups are recommended for studies examining immigration and health across development, depending on sample size and feasibility (Vidal, 2021).

Childhood in US. Participants who grew up in the US (US-born or immigration to the US before adolescence [ages 0–9]) were coded as 1. Individuals who were born in Latin America or were born in the US but grew up in Latin America, as determined by age at arrival and years living in the US, were coded as 0 (reference group). This can occur when an individual is born in the US but moved to another country during childhood. The sample size for participants coded as 1 (US upbringing) was ($n\_1 = 36$); for participants coded as 0 (Latin American upbringing), the sample size was ($n\_1 = 114$).

Childhood in US (English). As described above, participants who grew up in Latin America were coded as 0 (reference group; $n = 114$). Participants who grew up in the US *and* chose to complete the questionnaire in English (vs Spanish) were coded as 1 ($n = 27$).

Table 1
Participant Characteristics (n = 150) based on maternal country of childhood residence.

Participant Characteristics	Childhood in US (n = 36)[a]								Childhood in Latin America			
	Spanish				English				Total			
	(n = 9)				(n = 27)				(n = 114)			
Sociodemographic	*n*	%	M	SD	*n*	%	M	SD	*n*	%	M	SD
Maternal age			22.89	6.60			21.78	4.22			29.40	5.74
Age of migration (foreign-born)			1.89	1.83			5.0	2.45			20.29	5.21
Foreign-born	7	78.78			8	29.63			112	98.25		
English	0	0			27	100			5	4.39		
Income												
≤ $15,000	3	33.33			11	40.74			45	39.47		
$15,000 – $29,999	5	55.55			12	44.44			59	51.75		
$30,000 - $39,999	1	11.11			4	14.81			9	7.89		
≥ $40,000	0	0			0	0			1	.88		
Married/Partner	7	77.78			20	74.07			84	73.68		
Maternal education												
0 - 8th grade	1	11.11			1	3.70			52	45.61		
Some high school	3	33.33			11	40.74			29	25.44		
Graduated high school	3	33.33			8	29.63			20	17.54		
Some college	2	22.89			3	11.11			7	6.14		
4-year college degree	0	0			4	14.81			6	5.26		
Work outside home	5	55.56			13	48.15			31	27.19		
Health insurance												
None	4	44.44			4	14.82			93	81.58		
Medicare/Medicaid	4	44.44			23	85.19			20	17.54		
Private	1	2.78			0	0			1	.88		
Country of heritage												
Mexico	7	77.78			19	70.37			58	50.88		
Central America	0	0			3	11.11			47	41.22		
Caribbean	2	22.22			3	11.11			6	5.26		
South America	0	0			2	7.41			3	2.63		
Physiological												
Nulliparous	3	33.33			14	51.85			19	16.67		
Gestational Age (weeks)			28.79	1.80			28.70	.91			28.70	1.60
Cytokines: log transformed values												
Cytokine Profile			4.69	.53			5.10	.81			4.81	.76
Interleukin-beta			1.40	.25			1.40	.31			1.37	.26
TNF-alpha			1.26	.12			1.38	.17			1.30	.21
Interleukin-8			.48	.18			.65	.20			.56	.20
Interferon-gamma			1.56	.11			1.65	.25			1.59	.21
Cytokines: raw values (pg/ml)												
Interleukin-beta			28.55	15.67			31.84	25.00			28.16	20.40
TNF-alpha			18.70	6.06			25.70	10.24			22.34	11.41
Interleukin-8			3.29	1.56			4.97	2.30			4.02	1.85
Interferon-gamma			37.25	9.63			50.93	26.63			43.64	20.23
Pre-pregnancy weight (lbs)			155.9	34.3			149.0	31.9			147.7	28.7
Psychosocial												
Traumatic Avoidance Symptoms			5.89	3.48			7.0	3.51			5.54	2.79
Everyday Discrimination			1.11	2.67			6.15	6.85			2.33	3.95

Note.
[a] Participants who spent their childhood in the US (0–9 years old) based on nativity, age at migration, and years living in the US; *Childhood in US* participants are subdivided based on survey language selection (English vs Spanish).

5.2. Everyday discrimination

The 9-item Everyday Discrimination Scale (EDS) (Williams et al., 1997) was used to measure day-to-day perceived experiences of discrimination within the last year. It correlates with measures of institutional and interpersonal discrimination (Krieger et al., 2005) and does not prime the subjects to think about race (Deitch et al., 2003). Participants are asked to rate each item on a 5-point scale (*1 = never* to *5 = almost every day*). Higher scores indicate a higher frequency of perceived discrimination. The widely used EDS is also validated in Spanish (Park et al., 2018). Cronbach's standardized alpha for item consistency was .92 (English) and .87 (Spanish).

5.3. Traumatic avoidance symptoms

We collected data on the two trauma subscales of The Inventory of Depression and Anxiety Symptoms (IDAS-II), a measure comprised of symptom-based subscales (e.g., post-traumatic stress, obsessive compulsive, and bipolar disorders) consistent with the internalizing dimension of the Hierarchical Taxonomy Of Psychopathology (Watson et al., 2017a). It assesses psychiatric symptoms experienced within the last 2 weeks. The scale has been validated in English and Spanish (De la Rosa-et al., 2020). Participants are asked to rate each item on a 5-point scale (*1 = not at all* to *5 = extremely*) with higher scores indicating more severe symptoms. We omitted the *Traumatic Intrusions* subscale due to low Cronbach's standardized alpha for item consistency in Spanish (.53). We used the four-item *Traumatic Avoidance* subscale (e.g., *I avoided talking about bad experiences from my past*), which has a suggested 9.5 cut point based on criteria for impairment. It has a strong and specific association with PTSD diagnoses (Watson et al., 2017b). Cronbach's standardized alpha for item consistency was .84 (English) and .85 (Spanish).

5.4. Pro-inflammatory cytokine profile

The study blood draw was incorporated into the routine prenatal

blood draw followed by self-report measures, as previously described (Santos et al., 2018). A 6 ml blood sample was drawn from a peripheral vein into a chilled EDTA-vacutainer, placed immediately on ice and processed. Cytokines were measured using the 20-Plex Human ProcartaPlex™ by Thermo Fisher. This panel evaluates 20 protein targets in a single well using Luminex xMAP technology, which is a multiplex assay approach (Luminex 200™, Merck Millipore, Germany).

Cytokines associated with the NF-κB complex were selected based on prior reviews, demonstrating their key functional roles in obstetric and psychiatric studies (Yockey and Iwasaki, 2018; Katrinli et al., 2022; Gómez-Chávez et al., 2021). See the Supplemental file for a detailed description of the selection process. We excluded any cytokines with more than 10% missing data (e.g., Il-6) to minimize bias. First, cytokine values were log transformed to correct for non-normality; transformed variables were used in subsequent analyses. Then, we confirmed dimensionality of an inflammatory latent factor by conducting a confirmatory factor analysis (CFA). Model fit was examined using three standard fit indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), and the root mean squared error of approximation (RMSEA). CFI and TLI values above .95 and RMSEA values below .06 indicate good model fit (Hu et al., 1999). For the CFA, we used MPlus 8.4 using the maximum likelihood estimator (Muthén and Muthén, 1998). The CFA model fit the data well, $\chi 2$ ($df = 2$, $N = 150$) 2.78, $p = .25$, CFI = 1.00, TLI = .99, RMSEA = .05. Thus, results from the CFA supported the construction of a latent variable composed of four pro-inflammatory cytokines (IL-1β, TNF-α, IFN-γ, and IL-8), see Supplemental Fig. 1. Cytokines were then summed to create the aggregated cytokine profile for subsequent analyses, see Supplemental Fig. 2 for normality distribution. Summed scores based on theoretical premises and/or empirical evidence are considered plausible methods to identify inflammatory profiles of psychiatric symptoms during pregnancy (McCormack et al., 2023).

5.5. Covariates

In the two-mediator sequential model, we adjusted for *Maternal age, Nulliparous status, Gestational week*, and *Pre-pregnancy weight* given their relationship to prenatal cytokine levels in prior studies (Meyyazhagan et al.; Ross et al., 2022). Socioeconomic variables were not considered as covariates; later immigrant generation Latinas of Mexican heritage tend to have worse perinatal outcomes than their mothers despite higher levels of education and health insurance (McGlade et al., 2004). This phenomenon warrants a separate study.

5.6. Analytical plan

First, we calculated measures of central tendency and variance to describe demographics and inflammatory markers. We stabilized variances and addressed non-normality of *Everyday discrimination* (skewness: 2.15) and *Traumatic avoidance symptoms* (skewness: 1.99) by applying a log transformation before conducting mediation analyses. Given suggested guidelines for acceptable normality (below 1.5 and above −1.5) (Tabachnick et al., 2013), resulting distributions for the *Everyday discrimination* (.73) and *Traumatic avoidance symptoms* (1.40) were deemed acceptable. Second, we performed bivariate correlations to explore the associations between continuous study variables and check for multicollinearity ($r \geq .7$). Then, we used a Welch's *t*-test to test if *Traumatic avoidance symptoms* differed between those who grew up in the US vs those who grew up in Latin America. We used SAS 9.4 (SAS, Cary, NC) at a significance level of alpha = .05.

Lastly, to evaluate the hypotheses and potential mechanistic pathways, we employed two two-mediator sequential models using SAS PROCESS macro version 4.2 software. The PROCESS macro is a widely-used regression path analysis modeling tool (Hayes, 2022). In our study, Model 6 (a macro for serial mediation) was applied to assess the mediating role of *Everyday discrimination* and *Traumatic avoidance symptoms* in the relationship between *Childhood in US* and the *Cytokine profile* in model one. In model two, we used *Childhood in the US (English)* as the initial predictor (X). Bootstrapping with 95% confidence intervals (CI) for indirect effects was set at 5000 samples. If the 95% CI of the mediation effect did not include zero, the mediation effect was statistically significant at the .05 threshold. Percentile bootstrapped CIs were used to assess the statistical significance of the indirect effects. Percentile bootstraps may be less likely to result in Type 1 errors than bias-corrected bootstrapping in two-mediator sequential models (Tofighi and Kelley, 2020) and is considered the most appropriate method for the smallest sample sizes (Creedon et al., 2015).

One participant was missing cytokine assays (*Cytokine profile);* eight were missing *Pre-pregnancy weight*; and one was missing pregnancy history (*Nulliparous status*). Given that less than 10% of the data was missing, stochastic imputation was considered appropriate (Tsikriktsis, 2005).

6. Results

6.1. Relationships between childhood in the US and traumatic avoidance symptoms, and everyday discrimination and the cytokine profile

Bivariate analyses for model pathways *Childhood in US* and *Traumatic avoidance symptoms* (a_2) and *Everyday discrimination* and the *Cytokine profile* (b_1) were conducted before introducing them into the models.

A Welch's *t*-test showed that those who grew up in the US vs Latin America reported higher levels of traumatic avoidance symptoms, $t(51.69) = -2.09$, $p = .04$, $d = -.42$. Similarly, those who grew up in the US *and* chose the English questionnaire reported higher levels of traumatic avoidance symptoms than those who immigrated after childhood, $t(35.55) = -2.37$, $p = .02$, $d = -.53$.

Table 2 presents bivariate correlations for key continuous study variables and covariates. Multicollinearity was not a concern, as all the correlations were below the threshold ($r \geq .7$). *Everyday discrimination* and the *Cytokine profile* were not significantly correlated, $r(148) = -.08$, $p = .32$ before introducing them into the models.

6.2. Pathways between childhood in US, everyday discrimination, traumatic avoidance symptoms, and the cytokine profile

The two-mediator sequential models tested whether Latinas who grew up in the US (vs Latin America) had an elevated cytokine profile via two potential mediators, *Everyday discrimination* and *Traumatic avoidance symptoms,* as shown in Fig. 2. Table 3 presents path coefficients, confidence intervals, and p-values for direct pathways. Results for indirect pathways (using the bootstrap-derived 95% CI estimation procedure with 5000 bootstrap samples) from *Childhood in US* to the *Cytokine profile* are described below. CIs that do not include zero indicate significant indirect effects.

6.2.1. Indirect pathways for childhood in US

In the first pathway (indirect effect a_1b_1), we found non-significant negative indirect effects of *Childhood in US* via *Everyday discrimination*, to the *Cytokine profile* (Boot $b = -.101$, Boot $SE = .07$; 95% CI [−.280, .004]), indicating no mediation.

In the second pathway (indirect effect a_2b_2), we found non-significant indirect effects of *Childhood in US (English)*, via *Traumatic avoidance symptoms*, to the *Cytokine profile* (Boot $b = .125$, Boot $SE = .10$; 95% CI [-.059, .320]), indicating no mediation.

In the final pathway (cascading indirect effect $a_1d_{21}b_2$), we found significant indirect effects of *Childhood in US*, via the sequential mediating effect of *Everyday discrimination* on *Traumatic avoidance symptoms* to the *Cytokine profile,* (Boot $b = .047$, Boot $SE = .03$; 95% CI [.001, .126]), indicating mediation.

Table 2
Pearson's correlations for continuous study variables (N = 150).

Variable		1	2	3		4		5	6
1. Maternal age	Pearson's r	–							
	p-value	–							
2. Gestational week	Pearson's r	.102	–						
	p-value	.216	–						
3. Everyday discrimination	Pearson's r	.056	.027	–					
	p-value	.501	.744	–					
4. Traumatic avoidance symptoms	Pearson's r	.077	.069	.285	***	–			
	p-value	.346	.400	<.001		–			
5. Cytokine profile[a]	Pearson's r	.062	.007	−.082		.328	***	–	
	p-value	.454	.932	.317		<.001		–	
6. Pre-pregnancy weight	Pearson's r	−.102	−.047	−.031		−.042		−.059	–
	p-value	.216	.576	.771		.621		.583	–

Note. * p < .05, **p < .01, ***p < .001.
[a] Cytokine profile is a sum of the following cytokines: Interleukin-Iβ, Interferon gamma, tumor necrosis factor-α, Interleukin-8.

6.2.2. Model variance

The model explained 10.8% of the variance in *Traumatic avoidance symptoms* (adjusted R^2 = .108; p = .011), 4.0% of the variance in *Everyday discrimination* (adjusted R^2 = .040; p = .320), and 17.4% of the variance in the *Cytokine profile* (adjusted R^2 = .174; p > .001).

6.2.3. Indirect pathways for childhood in US (English)

In the first pathway (indirect effect a_1b_1), we found significant indirect effects of *Childhood in US (English),* via *Everyday discrimination*, to the *Cytokine Profile* (Boot b = −.185, Boot *SE* = .10; 95% CI [−.434, −.025]), indicating mediation.

In the second pathway (indirect effect a_2b_2), we found non-significant indirect effects of *Childhood in US (English)*, via *Traumatic avoidance symptoms*, to the *Cytokine profile* (Boot b = .151, Boot *SE* = .11; 95% CI [-.075, .382]), indicating no mediation.

In the final pathway (cascading indirect effect $a_1d_{21}b_2$), we found significant indirect effects of *Childhood in US (English)*, via the sequential mediating effect of *Everyday discrimination* on *Traumatic avoidance symptoms* to the *Cytokine profile,* (Boot b = .080, Boot *SE* = .04; 95% CI [.026, .183]), indicating mediation.

The residual effects of *Childhood in US (English)* on the *Cytokine profile*, (c_1 = .454, p = .021) remained significant after adding both potential mediators, indicating that *Everyday discrimination* on *Traumatic avoidance symptoms* partially mediated the *Childhood in US (English)* - *Cytokine profile* link.

6.2.4. Model variance

The model explained 11.8% of the variance in *Traumatic avoidance symptoms* (adjusted R^2 = .118; p = .009), 7.6% of the variance in *Everyday discrimination* (adjusted R^2 = .076; p = .055), and 20.5% of the variance in the *Cytokine profile* (adjusted R^2 = .205; p > .001).

7. Discussion

Guided by the race-based traumatic stress model, the present study examined the mechanistic role of post-migration discrimination on traumatic avoidance symptoms and an elevated cytokine profile (IL-1β, TNF-α, IFN-γ, and IL-8). In so doing, our findings provide insight into the immigrant paradox in which first generation immigrants, particularly of Mexican heritage, experience better maternal and child health outcomes than their US-born counterparts. Women who grew up in the US reported more discrimination and more traumatic avoidance symptoms than those who immigrated after childhood. Not only were these associations stronger for those who grew up in the US and selected the English questionnaire, but this group also had the most elevated pro-inflammatory cytokine profile. In the first pathway, discrimination was *negatively* associated with the cytokine profile when accounting for trauma symptoms and growing up in the US. In the second pathway, traumatic avoidance symptoms alone did not mediate the relationship between growing up in the US and an elevated pro-inflammatory cytokine profile. Rather, discrimination and traumatic avoidance symptoms sequentially provided mechanistic support for the relationship between growing up in the US and an elevated pro-inflammatory cytokine profile. Indeed, more frequent experiences of discrimination functioned as a catalyst forming divergent pathways. Discrimination either contributed to avoidance symptoms and a subsequent elevated cytokine profile or, conversely, to a suppressed cytokine profile.

Women who grew up in the US and selected the English questionnaire reported the highest levels of discrimination. Indeed, greater exposure to and integration into US society has been associated with increased discrimination with striking consistency (Santana, 2018; Pérez et al., 2008; Cook et al., 2009; Flippen et al., 2015; Viruell-Fuentes, 2007; Ponting et al., 2020). Interviews with women of Mexican heritage emphasize childhood as a critical period in which experiences of discrimination towards oneself and family members shaped self-identity across the life trajectory, with potential lifelong health implications (Viruell-Fuentes, 2007). Among women who grew up in the US, all outcomes were worse for those who chose the English questionnaire. Although greater adaptation to US culture (acculturation) may be one plausible explanation, Latinas who attend US schools during childhood will inevitably develop similarly high levels of English language acculturation by adulthood (Suárez-Orozco et al., 2015). What varies more widely within *this* group is the extent to which heritage language is maintained (*en*culturation) (Suárez-Orozco et al., 2015). Women who maintained greater levels of heritage language may have had more access to co-ethnic physical and psychological spaces during childhood (Suárez-Orozco et al., 2015). These protective psychosocial resources may have extended into early adulthood. Moreover, Spanish language choice may have reflected positive ethnic identity (i.e., a sense of belonging and pride for one's ethnic group), a hypothesis that could be examined in future studies. After all, "language acts are acts of identity" (Tabouret-Keller, 2017).

Growing up in the US and selecting the English questionnaire was also associated with an elevated cytokine profile. Similarly, a recent review found that US nativity and English language selection has been associated with higher levels of inflammatory markers in Latino populations (Scholaske et al., 2021), acculturation markers closely linked to the country in which a person grew up. Given that a pro-inflammatory phenotype has well-established roots in early psychosocial adversity (Baumeister et al., 2016), our findings suggest that growing up as a Latina in the US may contribute to these epidemiological patterns. Indeed, minoritized status has been associated with a dysregulated glucocorticoid-immune negative feedback loop during pregnancy (Corwin et al., 2013), a proposed biological mechanism for chronic inflammation and subsequent adverse mother and child outcomes (Hantsoo et al., 2019). Specifically, perceived threat activates the immune system to release inflammatory signals. Generally, glucocorticoids (e.g., cortisol) suppress these inflammatory responses, but prolonged

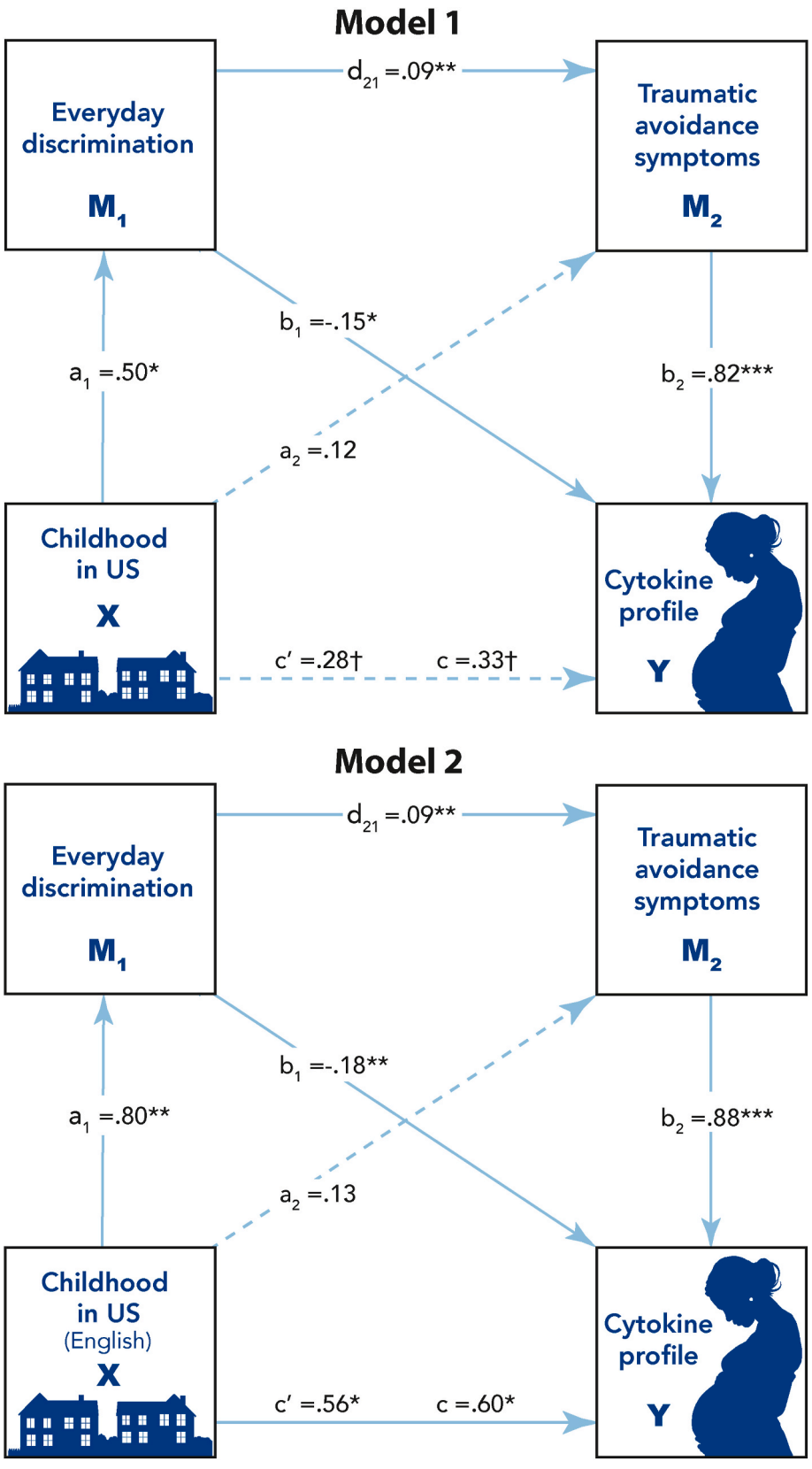


Fig. 2. Two-mediator sequential models depicting hypothesized psychosocial mechanisms by which growing up in the US may be associated with the pro-inflammatory cytokine profile.

Notes. X is the predictor; M_1 and M_2 are mediators one and two, respectively; and Y is the outcome variable; Childhood in Latin America (ref.) = X_0; a_1, a_2, b_1, b_2, c, c′, and d_{21} represent unstandardized path coefficients. c′ denotes the direct effect of *Childhood in US* on the *Cytokine profile*; c denotes the total effect of *Childhood in US* on the *Cytokine profile* via mediators; non-significant paths are drawn with dotted lines; †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 3
Path coefficients for the two-mediator sequential models.

Direct Paths	Estimate	*β*	*B*	*SE*	p-value		95% CI	
Model 1 ($n = 150$)							LL	UL
(X) Childhood in US→(M_1) Everyday discrimination	a_1	.486	.497	.228	.031	[b]	.047	.948
(X) Childhood in US→(M_2) Traumatic avoidance symptoms	a_2	.333	.116	.086	.131		−.035	.266
(M_1) Everyday discrimination→(Y) Cytokine profile	b_1	−.271	−.153	.060	.011	[b]	−.270	−.036
(M_1) Everyday discrimination→(M_2) Traumatic avoidance symptoms	d_{21}	.259	.088	.027	.002	[c]	.034	.142
(M_2) Traumatic avoidance symptoms→(Y) Cytokine profile	b_2	.375	.823	.175	<.001	[d]	.467	1.159
(X) Childhood in US→(Y) Cytokine profile	c	.439	.331	.168	.051	[a]	−.001	.664
(X) Childhood in US→(Y) Cytokine profile	c'	.369	.278	.161	.086	[a]	−.040	.595
Model 2 ($n = 141$)								
(X) Childhood in US (English)→(M_1) Everyday discrimination	a_1	.776	.802	.252	.002	[c]	.305	1.300
(X) Childhood in US (English)→(M_2) Traumatic avoidance symptoms	a_2	.382	.132	.086	.125		−.037	.301
(M_1) Everyday discrimination (English)→(Y) Cytokine profile	b_1	−.238	−.177	.062	.005	[c]	−.299	−.055
(M_1) Everyday discrimination→(M_2) Traumatic avoidance symptoms	d_{21}	.260	.087	.028	.003	[c]	.031	.143
(M_2) Traumatic avoidance symptoms→(Y) Cytokine profile	b_2	.394	.875	.183	<.001	[d]	.513	1.263
(X) Childhood in US (English)→(Y) Cytokine profile	c	.602	.461	.189	.016	[b]	.087	.835
(X) Childhood in US (English)→(Y) Cytokine profile	c'	.557	.423	.183	.021	[b]	.067	.788

Note: Childhood in Latin America (reference) = 0; β = standardized coefficients for dichotomous predictors are partially standardized; B = unstandardized coefficient; SE= Standard Error; CI = Confidence Interval; LL = lower limit 2.5%; UP = Upper Limit 2.5%; model is adjusted for *Maternal age, Nulliparous status, Gestational week*, and *Pre-pregnancy weight;* .

[a] $p < .10$.
[b] $p < .05$.
[c] $p < .01$.
[d] $p < .001$.

stress-induced cortisol secretion can desensitize cytokines to the anti-inflammatory properties of cortisol (Miller et al., 2011). This may be one way in which a mother's early life psychosocial stressors may potentiate a pro-inflammatory phenotype during pregnancy, a sensitive period for immune plasticity (Hantsoo et al., 2019). For instance, pregnant women who experienced traumatic stress in both early childhood *and* pregnancy were more likely to have a higher pro-inflammatory aggregated score (CRP, IL-6, TNF-a, and IL-1β) than women who were exposed to traumatic stress either during pregnancy or early childhood (Aschbacher et al., 2021). Furthermore, pregnant women who have experienced chronic early life stress may have more pro-inflammatory (NF-κB) transcription factor activity than mothers who have not (Méndez Leal et al., 2023).

When accounting for traumatic avoidance symptoms and growing up in the US, discrimination was negatively associated with the cytokine profile. In other words, women who immigrated after childhood and did not experience trauma symptoms likely differed in their immunological response to discrimination. Although most studies have found a positive association between inflammatory markers and discrimination, findings have not been consistent (Cuevas et al., 2020). For instance, one study found that everyday discrimination was associated with lower inflammation levels, whereas lifetime discrimination was associated with higher inflammation levels in a sample of Puero Rican middle-aged adults in mainland US (Cuevas et al., 2019). Similarly, prenatal depressive symptoms have also been associated with lower (Shelton et al., 2015) and higher levels of cytokines(Leff Gelman et al., 2019). In women whose depressive symptoms were characterized by lower cytokine levels, cytokines were inversely related to higher cortisol levels (Shelton et al., 2015), suggesting an active (rather than dysregulated) glucocorticoid-immune feedback loop. In contrast, pregnant women with depression characterized by high cytokine levels may have more severe(Leff Gelman et al., 2019) and more chronic symptoms (Bränn et al., 2022), and/or a lifetime history of trauma (Blackmore et al., 2011; Bianciardi et al., 2021). Thus, our findings suggest that emotional responses to and chronicity of discrimination may be critical modifiers in understanding how experiences of discrimination may influence the maternal inflammatory milieu. In either case, a healthy pregnancy requires a tightly coordinated immune system, in which prenatal over- and under-production of pro-inflammatory cytokines may adversely relate to maternal and child health outcomes (Shelton et al., 2015; Sherer et al., 2022).

Growing up in the US was associated not only with an elevated cytokine profile and more frequent experiences of discrimination but with higher levels of traumatic avoidance symptoms. Indeed, more frequent experiences of discrimination provided mechanistic support for higher levels of avoidance symptoms. Although the post-migration period may be traumatic at any age, unaddressed parental trauma may be transmitted across generations (Cerdeña et al., 2021). Vicariously and directly experienced traumatic stress may have been compounded for those who grew up in the US during sensitive periods for immune system development and self-identity formation. Children may also bear the burden of anti-immigrant climates, including PTSD symptoms stemming from fear of parental separation (Chavez-Dueñas et al., 2019) and interpersonal discrimination (Flores et al., 2010; Brabeck et al., 2022). Symptoms may not necessarily subside by adulthood given the low rates of PTSD remission in Latino populations and the exacerbating role of chronic discrimination in trauma symptoms (Sibrava et al., 2019).

Traumatic avoidance symptoms were also associated with an elevated cytokine profile in accordance with PTSD research in non-pregnant populations. Avoidance symptoms may be a particularly relevant trauma symptom cluster. They may prolong and exacerbate traumatic stress by perpetuating the feeling that memories are dangerous (Foa et al., 1986), and sociocultural context may shape their expression and prevalence. For instance, Latino collectivistic culture values of respect and emotional restraint may encourage internalizing or blocking out negative emotions to maintain group harmony (Schneider et al., 2018). As such, Latino/a individuals may be more likely to use self-blame and avoidant coping strategies in response to traumatic stress than other racial and ethnic groups (Alcántara et al., 2013). On a molecular level, the relationship between an elevated cytokine profile and traumatic avoidant symptoms may have reflected more severe trauma symptoms. However, few studies have examined immune dysregulation in relation to specific trauma symptom clusters, which precludes a definitive understanding.

7.1. Limitations

First, we cannot determine causality in a cross-sectional study. However, longitudinal studies examining the relationship between

trauma symptoms and a pro-inflammatory phenotype suggest a bi-directional (rather than strictly correlational) relationship (Sumner et al., 2020). Although discrimination has predicted trauma symptoms in longitudinal studies (Flores et al., 2010; Cheng et al., 2015), discrimination may have also functioned bi-directionally to exacerbate trauma symptoms. Second, the sample size precluded dividing participants by nativity and age at migration in childhood. Larger samples could examine more nuanced outcomes using a developmental framework and additional factors, such as parent and child immigration status and pre-migration factors. Given the heterogeneity within the pan-ethnic category, "Latina", additional layers of complexity may also emerge based on documentation status, skin color, and heritage country. Third, ethnic minoritized context likely differs based on where in the US an individual grew up and currently resides (e.g., neighborhood composition), which could be explored in future studies. Fourth, given the small number of participants who grew up in the US, differences between groups based on language selection should be considered exploratory. The lack of prior research comparing trauma symptoms between postmigration groups makes it difficult to know if this may be a clinically significant difference. Finally, we did not use an acculturation scale. However, acculturation scales are not without disadvantages, including potentially obscuring the role of childhood context in health disparities – particularly when used uniformly across immigrant generations (Viruell-Fuentes, 2007, Viruell-Fuentes et al., 2012). Distinct categories based on developmental age at migration enabled us to use a life course lens to examine biomarkers with etiological roots in childhood (Miller et al., 2011).

7.2. Implications

The present study integrates the race-based traumatic stress model to identify upstream pathways for preventive interventions and advocacy. Post-migration discrimination is likely most consequential, not for temporary migrants, but for families who have acculturated into US society. The far-reaching implications of discrimination may extend not only to the children who grow up as ethnic minorities, but to the future children they may later bear. Currently, discrimination-related PTSD symptoms may not necessarily align with the "post" criteria in the *Diagnostic and Statistical Manual of Mental Disorders* (fifth edition; DSM–5) given its pervasive and cumulative etiology (Comas-Díaz et al., 2019). Alternative screening practices have been proposed: expanded diagnostic criterion, a separate diagnosis for race-based traumatic stress, or, at minimum, formal acknowledgement of discrimination as traumatic stress (Holmes et al., 2016). To prevent further stigmatization, however, the race-based traumatic stress model maintains that psychological responses to structural and interpersonal discrimination be conceptualized as an emotional injury rather than a mental health disorder (Carter, 2007). Furthermore, culturally congruent interventions must consider the broader *multi-level* etiology of trauma symptoms. Recommendations for Healing Ethno-Racial Trauma (HEART) have been made on community, family, and individual levels (Chavez-Dueñas et al., 2019). Examples include "know your rights" workshops for immigrants, planning events that celebrate the beauty of Latino heritage, and challenging self-blaming statements (Chavez-Dueñas et al., 2019).

Despite substantial evidence linking trauma symptoms to inflammation in non-pregnant individuals, a recent review found no prior studies investigating this association during pregnancy (Ravi et al., 2022). Given the present study's findings, trauma symptoms merit further research, particularly in pregnant populations who may experience greater levels of chronic traumatic stress – including discrimination.

8. Conclusion

Guided by the race-based traumatic stress model, the present study elucidates important pathways by which discrimination may be differentially psychologically and biologically embodied across post-migration immigrant generations. Maternal immune dysregulation carries consequential implications for the health of a mother and her child, including pregnancy complications, preterm birth, and impaired fetal neurodevelopment. Understanding the multi-level social context(s) in which immune dysregulation may develop across post-migration generations in the US may provide targets of preventive intervention and advocacy. Research in immigrant mother and child health will unlikely move forward until the relationship between immigration and health is contextualized in time (e.g., developmental period of immigration, sociopolitical/historical context) or place (sociocultural context).

CRediT authorship contribution statement

Rebeca Alvarado-Harris: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Krista Perreira:** Writing – review & editing, Supervision, Conceptualization. **Cheryl L. Woods-Giscombe:** Supervision. **William Roger Mills-Koonce:** Writing – review & editing, Supervision. **Hudson P. Santos:** Jr, Writing – review & editing, Supervision, Resources, Investigation, Funding acquisition, Conceptualization.

Funding

Rebeca Alvarado-Harris was funded by 1F31NR020843, Caroline H. and Thomas S. Royster Fellowship, and Linda Waring Matthews Research Award

Hudson P Santos Jr, was funded by the NIH Clinical and Translational Science Award, North Carolina Translational & Clinical Sciences Institute (UL1TR001111; #550KR131619), the Senich Innovation Award and the SPARK pilot program from the University of North Carolina at Chapel Hill School of Nursing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Hudson P Santos Jr reports financial support was provided by National Institutes of Health. Rebeca Alvarado-Harris reports financial support was provided by National Institutes of Health. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bbih.2024.100914.

Data availability

Data will be made available on request.

References

Alcántara, C., Casement, M.D., Lewis-Fernández, R., 2013. Conditional risk for PTSD among Latinos: a systematic review of racial/ethnic differences and sociocultural explanations. Clin. Psychol. Rev. 33 (1), 107–119.

Alegria, M., et al., 2007. Looking beyond nativity: the relation of age of immigration, length of residence, and birth cohorts to the risk of onset of psychiatric disorders for latinos. Res. Hum. Dev. 4 (1), 19–47.

Alegria, M., et al., 2019. The effect of minority status and social context on the development of depression and anxiety: a longitudinal study of Puerto Rican descent youth. World Psychiatr. 18 (3), 298–307.

Altinoz, M.A., et al., 2018. The NF-κB signaling pathway: an important therapeutic target in psychiatric disorders. Mol. Psychiatr. 23 (3), 490–491.

Aschbacher, K., et al., 2021. Adversity in early life and pregnancy are immunologically distinct from total life adversity: macrophage-associated phenotypes in women exposed to interpersonal violence. Transl. Psychiatry 11 (1), 391.
Baumeister, D., et al., 2016. Childhood trauma and adulthood inflammation: a meta-analysis of peripheral C-reactive protein, interleukin-6 and tumour necrosis factor-α. Mol. Psychiatr. 21 (5), 642–649.
Bersani, B.E., Morabito, M.S., 2020. Immigrant disparities in suicide ideation: variation across age of migration, gender, and nativity. J. Immigr. Minority Health 22 (5), 881–887.
Beurel, E., Toups, M., Nemeroff, C.B., 2020. The bidirectional relationship of depression and inflammation: double trouble. Neuron 107 (2), 234–256.
Bianciardi, E., et al., 2021. Inflammatory markers of perinatal depression in women with and without history of trauma. Riv. Psichiatr. 56 (5), 237–245.
Blackmore, E.R., et al., 2011. Psychiatric symptoms and proinflammatory cytokines in pregnancy. Psychosom. Med. 73 (8), 656–663.
Brabeck, K.M., et al., 2022. Discrimination and PTSD among Latinx immigrant youth: the moderating effects of gender. Psychol Trauma 14 (1), 11–19.
Bränn, E., et al., 2022. Longitudinal assessment of inflammatory markers in the peripartum period by depressive symptom trajectory groups. Brain Behav Immun Health 22, 100468.
Breslau, J., et al., 2011. Migration from Mexico to the United States and conduct disorder: a cross-national study. Arch Gen Psychiatry 68 (12), 1284–1293.
Carter, R.T., 2007. Racism and psychological and emotional injury: recognizing and assessing race-based traumatic stress. Counsel. Psychol. 35 (1), 13–105.
Cerdeña, J.P., Rivera, L.M., Spak, J.M., 2021. Intergenerational trauma in Latinxs: a scoping review. Soc. Sci. Med. 270, 113662.
Chavez-Dueñas, N.Y., et al., 2019. Healing ethno-racial trauma in Latinx immigrant communities: cultivating hope, resistance, and action. Am. Psychol. 74 (1), 49–62.
Cheng, H.L., Mallinckrodt, B., 2015. Racial/ethnic discrimination, posttraumatic stress symptoms, and alcohol problems in a longitudinal study of Hispanic/Latino college students. J. Counsel. Psychol. 62 (1), 38–49.
Christian, L.M., 2012. Psychoneuroimmunology in pregnancy: immune pathways linking stress with maternal health, adverse birth outcomes, and fetal development. Neurosci. Biobehav. Rev. 36 (1), 350–361.
Christian, L.M., 2019. At the forefront of psychoneuroimmunology in pregnancy: implications for racial disparities in birth outcomes PART 1: behavioral risks factors. Neurosci. Biobehav. Rev. 117, 319–326.
Cobas, J.A., et al., 1996. Acculturation and low-birthweight infants among Latino women: a reanalysis of HHANES data with structural equation models. Am. J. Publ. Health 86 (3), 394–396.
Comas-Díaz, L., Hall, G.N., Neville, H.A., 2019. Racial trauma: theory, research, and healing: introduction to the special issue. Am. Psychol. 74, 1–5.
Cook, B., et al., 2009. Pathways and correlates connecting Latinos' mental health with exposure to the United States. Am. J. Publ. Health 99 (12), 2247–2254.
Corwin, E.J., et al., 2013. Immune dysregulation and glucocorticoid resistance in minority and low income pregnant women. Psychoneuroendocrinology 38 (9), 1786–1796.
Coussons-Read, M.E., Okun, M.L., Nettles, C.D., 2007. Psychosocial stress increases inflammatory markers and alters cytokine production across pregnancy. Brain Behav. Immun. 21 (3), 343–350.
Creedon, P.S., Hayes, A.F., 2015. Small sample mediation analysis: how far can we push the bootstrap. In: Annual Conference of the Association for Psychological Science.
Cuevas, A.G., et al., 2019. The association between perceived discrimination and allostatic load in the Boston Puerto Rican health study. Psychosom. Med. 81 (7), 659–667.
Cuevas, A.G., et al., 2020. Discrimination and systemic inflammation: a critical review and synthesis. Brain Behav. Immun. 89, 465–479.
Davila, M., McFall, S.L., Cheng, D., 2009. Acculturation and depressive symptoms among pregnant and postpartum Latinas. Matern. Child Health J. 13 (3), 318–325.
de la Rosa, I.A., 2002. Perinatal outcomes among Mexican Americans: a review of an epidemiological paradox. Ethn. Dis. 12 (4), 480–487.
De la Rosa-Cáceres, A., et al., 2020. Spanish adaptation of the inventory of depression and anxiety symptoms (IDAS-II) and a study of its psychometric properties. J. Affect. Disord. 271, 81–90.
Deitch, E.A., et al., 2003. Subtle yet significant: the existence and impact of everyday racial discrimination in the workplace. Hum. Relat. 56 (11), 1299–1324.
Falgas-Bague, I., et al., 2023. Association of sociocultural stressors with bipolar disorder onset in Puerto Rican youth growing up as members of a minoritized ethnic group: results from the Boricua Youth Longitudinal Study. Lancet Reg Health Am 24, 100549.
Flippen, C.A., Parrado, E.A., 2015. Perceived discrimination among Latino immigrants in new destinations: the case of Durham, NC. Socio. Perspect. 58 (4), 666–685.
Flores, E., et al., 2010. Perceived racial/ethnic discrimination, posttraumatic stress symptoms, and health risk behaviors among Mexican American adolescents. J. Counsel. Psychol. 57 (3), 264–273.
Foa, E.B., Kozak, M.J., 1986. Emotional processing of fear: exposure to corrective information. Psychol. Bull. 99 (1), 20–35.
Muthén, L.K., Muthén, B.O., 1998-2017. Mplus User's Guide. Los Angeles, CA.
García Coll, C.T. and A.K. Marks, *The Immigrant Paradox in Children and Adolescents : Is Becoming American a Developmental Risk?* 2012, Washington, D.C.: Washington, D.C. : American Psychological Association, c2012.
Gillespie, S.L., et al., 2021. Racial discrimination and stress across the life course: associations with prenatal inflammation, perceived stress, and depressive symptoms. Nurs. Res. 70 (5S), S21–S30.
Gómez-Chávez, F., et al., 2021. NF-κB and its regulators during pregnancy. Front. Immunol. 12, 679106.
Han, V.X., et al., 2021. Maternal acute and chronic inflammation in pregnancy is associated with common neurodevelopmental disorders: a systematic review. Transl. Psychiatry 11 (1), 71.
Hantsoo, L., et al., 2019. Inflammation: a proposed intermediary between maternal stress and offspring neuropsychiatric risk. Biol. Psychiatr. 85 (2), 97–106.
Harris, R.A., Santos Jr., H.P., 2020. Maternal depression in Latinas and child socioemotional development: a systematic review. PLoS One 15 (3), e0230256.
Hayes, A.F., 2022. Introduction to Mediation, Moderation, and Conditional Process Analysis : A Regression-Based Approach, UNITED STATES. Guilford Publications, New York.
Hillemeier, M.M., Landale, N.S., Oropesa, R.S., 2015. Asthma in US Mexican-origin children in early childhood: differences in risk and protective factors by parental nativity. Acad Pediatr 15 (4), 421–429.
Holmes, S.C., Facemire, V.C., DaFonseca, A.M., 2016. Expanding criterion a for posttraumatic stress disorder: considering the deleterious impact of oppression. Traumatology 22 (4), 314–321.
Hu, L.t., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ. Model.: A Multidiscip. J. 6 (1), 1–55.
Katrinli, S., et al., 2022. The role of the immune system in posttraumatic stress disorder. Transl. Psychiatry 12 (1), 313.
Krieger, N., et al., 2005. Experiences of discrimination: validity and reliability of a self-report measure for population health research on racism and health. Soc. Sci. Med. 61 (7), 1576–1596.
Larrabee Sonderlund, A., Schoenthaler, A., Thilsing, T., 2021. The association between maternal experiences of interpersonal discrimination and adverse birth outcomes: a systematic review of the evidence. Int. J. Environ. Res. Publ. Health 18 (4).
Leff Gelman, P., et al., 2019. The cytokine profile of women with severe anxiety and depression during pregnancy. BMC Psychiatr. 19 (1), 104.
McCormack, C., Abuaish, S., Monk, C., 2023. Is there an inflammatory profile of perinatal depression? Curr. Psychiatr. Rep. 25 (4), 149–164.
McGlade, M.S., Saha, S., Dahlstrom, M.E., 2004. The Latina paradox: an opportunity for restructuring prenatal care delivery. Am. J. Publ. Health 94 (12), 2062–2065.
Méndez Leal, A.S., et al., 2023. Maternal early life stress is associated with pro-inflammatory processes during pregnancy. Brain Behav. Immun. 109, 285–291.
Meyyazhagan, A., et al., Cytokine see-saw across pregnancy, its related complexities and consequences. Int. J. Gynecol. Obstet. n/a(n/a).
Miller, G.E., Chen, E., Parker, K.J., 2011. Psychological stress in childhood and susceptibility to the chronic diseases of aging: moving toward a model of behavioral and biological mechanisms. Psychol. Bull. 137 (6), 959–997.
Padilla, Y.C., Hamilton, E.R., Hummer, R.A., 2009. Beyond the epidemiological paradox: the health of Mexican American children at age 5. Soc. Sci. Q. 90 (5), 1072–1088.
Page, R.L., 2004. Positive pregnancy outcomes in Mexican immigrants: what can we learn? J. Obstet. Gynecol. Neonatal Nurs. 33 (6), 783–790.
Park, I.J.K., et al., 2018. Racial/ethnic discrimination and mental health in Mexican-origin youths and their parents: testing the "linked lives" hypothesis. J. Adolesc. Health 62 (4), 480–487.
Pérez, D.J., Fortuna, L., Alegria, M., 2008. Prevalence and correlates of everyday discrimination among U.S. Latinos. J. Community Psychol. 36 (4), 421–433.
Ponting, C., et al., 2020. Postpartum depressive symptoms in low-income Latinas: cultural and contextual contributors. Cult. Divers Ethnic Minor. Psychol. 26 (4), 544–556.
Ravi, M., Bernabe, B., Michopoulos, V., 2022. Stress-related mental health disorders and inflammation in pregnancy: the current landscape and the need for further investigation. Front. Psychiatr. 13.
Ross, K.M., et al., 2022. Inflammatory and immune marker trajectories from pregnancy to one-year post-birth. Cytokine 149, 155758.
Ruiz, R.J., et al., 2007. The relationships among acculturation, body mass index, depression, and interleukin 1-receptor antagonist in Hispanic pregnant women. Ethn. Dis. 17 (2), 338–343.
Saadat, N., et al., 2022. Psychosocial and behavioral factors affecting inflammation among pregnant African American women. Brain, Behavior, & Immunity - Health 22, 100452.
Santana, E., 2018. Situating perceived discrimination: how do skin color and acculturation shape perceptions of discrimination among latinos? Socio. Q. 59 (4), 655–677.
Santos Jr., H.P., et al., 2018. Discrimination exposure and DNA methylation of stress-related genes in Latina mothers. Psychoneuroendocrinology 98, 131–138.
Schneider, A., Gudiño, O.G., 2018. Predicting avoidance symptoms in U.S. Latino youth exposed to community violence: the role of cultural values and behavioral inhibition. J. Trauma Stress 31 (4), 509–517.
Scholaske, L., et al., 2018. Acculturation and interleukin (IL)-6 concentrations across pregnancy among Mexican-American women. Brain Behav. Immun. 73, 731–735.
Scholaske, L., Wadhwa, P.D., Entringer, S., 2021. Acculturation and biological stress markers: a systematic review. Psychoneuroendocrinology 132, 105349.
Schroder, K., et al., 2004. Interferon-γ: an overview of signals, mechanisms and functions. J. Leukoc. Biol. 75 (2), 163–189.
Shelton, M.M., Schminkey, D.L., Groer, M.W., 2015. Relationships among prenatal depression, plasma cortisol, and inflammatory cytokines. Biol. Res. Nurs. 17 (3), 295–302.
Sherer, M.L., et al., 2022. The immune phenotype of perinatal anxiety. Brain Behav. Immun. 106, 280–288.
Sibrava, N.J., et al., 2019. Posttraumatic stress disorder in African American and Latinx adults: Clinical course and the role of racial and ethnic discrimination. Am. Psychol. 74 (1), 101–116.

Slavich, G.M., 2020. Social safety theory: a biologically based evolutionary perspective on life stress, health, and behavior. Annu. Rev. Clin. Psychol. 16, 265–295.
Street, A.E., Dardis, C.M., 2018. Using a social construction of gender lens to understand gender differences in posttraumatic stress disorder. Clin. Psychol. Rev. 66, 97–105.
Structural Racism and Discrimination, 2023 [cited 2023; Available from. https://www.nimhd.nih.gov/resources/understanding-health-disparities/srd.html#:%7E:text=Structural%20racism%20and%20discrimination%20.
Suárez-Orozco, C., Abo-Zena, Mona M., Marks, Amy K., 2015. Transitions : the Development of Children of Immigrants. New York University Press, New York: New York [2015].
Sumner, L.A., et al., 2011. The influence of prenatal trauma, stress, social support, and years of residency in the US on postpartum maternal health status among low-income Latinas. Matern. Child Health J. 15 (7), 1046–1054.
Sumner, J.A., et al., 2020. Posttraumatic stress disorder and inflammation: untangling issues of bidirectionality. Biol. Psychiatr. 87 (10), 885–897.
Tabachnick, B.G., Fidell, L.S., 2013. Using Multivariate Statistics. Pearson Education.
Tabouret-Keller, A., 2017. Language and identity. In: The Handbook of Sociolinguistics, pp. 315–326.
Tofighi, D., Kelley, K., 2020. Indirect effects in sequential mediation models: evaluating methods for hypothesis testing and confidence interval formation. Multivariate Behav. Res. 55 (2), 188–210.
Tsikriktsis, N., 2005. A review of techniques for treating missing data in OM survey research. J. Oper. Manag. 24 (1), 53–62.
Vidal, E.M. (Ed.), 2021. Leave No Migrant behind: the 2030 Agenda. International Organization for Migration (IOM), Geneva.
Viruell-Fuentes, E.A., 2007. Beyond acculturation: immigration, discrimination, and health research among Mexicans in the United States. Soc. Sci. Med. 65 (7), 1524–1535.
Viruell-Fuentes, E.A., Miranda, P.Y., Abdulrahim, S., 2012. More than culture: structural racism, intersectionality theory, and immigrant health. Soc. Sci. Med. 75 (12), 2099–2106.
Watson, D., O'Hara, M.W., 2017a. *Understanding The Emotional Disorders: A Symptom-Level Approach Based on the IDAS-II*. Understanding the Emotional Disorders: A Symptom-Level Approach Based on the IDAS-II. Oxford University Press, New York, NY, US ix, 338-ix, 338.
Watson, D., et al., 2017b. 175The structure, validity, and specificity of PTSD symptoms. In: Understanding the Emotional Disorders: A Symptom-Level Approach Based on the IDAS-II. Oxford University Press, 0.
Williams, D.R., et al., 1997. Racial differences in physical and mental health:socio-economic status, stress and discrimination. J. Health Psychol. 2 (3), 335–351.
Yockey, L.J., Iwasaki, A., 2018. Interferons and proinflammatory cytokines in pregnancy and fetal development. Immunity 49 (3), 397–412.
Yuan, N., et al., 2019. Inflammation-related biomarkers in major psychiatric disorders: a cross-disorder assessment of reproducibility and specificity in 43 meta-analyses. Transl. Psychiatry 9 (1), 233.