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Article

Household fear of deportation in relation to chronic stressors and salivary proinflammatory cytokines in Mexican-origin families post-SB 1070

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ABSTRACT

Sociologists recognize that immigration enforcement policies are forms of institutionalized racism that can produce adverse health effects in both undocumented and documented Latinos and Mexican-origin persons in the United States. Despite this important advancement, little research examines the relationship between fear of immigration enforcement and biobehavioral health in mixed-status Mexican-origin families. This study applies an embodiment of racism approach to examine how household fear of deportation (FOD) is related to differences in salivary proinflammatory cytokines (IL-1β, IL-6, IL-8, and TNFα) in healthy Mexican-origin families with at least one immigrant, living in Phoenix, AZ. Participants were 111 individuals (n = 46 adults, 72% female; n = 65 children, 49% female) from 30 low-income, mixed-status families. During a home visit, anthropometric measures and saliva were collected from each family member and a household survey was administered. Saliva was assayed for salivary IL-1β, IL-6, IL-8, and TNFα. Random effects multilevel structural equation models estimated the relationship between household FOD and a salivary proinflammatory cytokine latent variable between families, while controlling for other chronic stressors (economic/occupational, immigration, parental, and family conflict). Household FOD ($\beta = 0.68$, $p = 0.04$) and family conflict chronic stress ($\beta = 1.96$, $p = 0.03$) were strongly related to elevated levels of proinflammatory cytokines between families. These results were consistent in non-mixed and mixed-status families. Future research is needed to characterize what aspects of living with an undocumented family member shape the physical health outcomes of persons with authorized status or US-citizenship.

Introduction

It is estimated that 16.7 million persons in the United States (US) live with at least one unauthorized immigrant in their household. Of these 16.7 million, 8.2 million are US-born or naturalized citizens, with 72% of these citizens being minor children (Mathema, 2017). Federal immigration enforcement includes policies and practices meant to facilitate the identification, detention and deportation of immigrants with an unlawful presence in the US. Through policies like Section 287(g)[1] and Secure Communities, the US Department of Homeland Security's immigration agencies (e.g., Customs and Border Protection [CBP] and Immigration and Customs Enforcement [ICE]) have largely relied on state and local law enforcement for information about and the temporary detention of non-U.S. citizens (Rhodes et al., 2015).

The local implementation of immigration enforcement policies (IEP) has several consequences to the social fabric of many US urban and rural communities. First, IEP criminalize unauthorized immigrant status (Dowling & Inda, 2013; Provine, Varsanyi, Lewis & Decker, 2016;

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[1] Section 287(g), often abbreviated s287(g), is a statute in the Immigration Reform and Immigrant Responsibility Act of 1996 which makes it possible for local law enforcement agencies to act as an extension of ICE by having law enforcement agents train to identify, apprehend and relinquish immigrants with an unlawful presence in the US to ICE. ICE deputizes local law enforcement officers, but it is up to the leaders of local law enforcement agencies to select officers to participate in the program as it requires more human and financial resources to implement the program (Magaña & Lee, 2014).

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Armenta, 2017). Second, IEP legitimize increased police surveillance, racial profiling and the mistreatment of persons who appear "illegal," which often symbolizes Latina/o/x or Mexican (Romero, 2011; Aranda & Vaquera, 2015; Provine et al., 2016). Third, IEP are thought to produce fear and mistrust in local law enforcement, leaving crimes unreported and communities less safe (Androff, Ayon, Becerra & Gurrola, 2011; Kirk, Papachristos, Fagan & Tyler, 2012). This mistrust and fear has led Latino and Mexican-origin families to evade services from government agencies, despite their children qualifying for them (Van Hook & Balistreri, 2006; Dreby, 2015).

More recently, sociologists have considered IEP as institutionalized racism because they not only stem from "colorblind" policies that are not specifically targeting racial/ethnic minorities, but encourage racialized practices among law enforcement (Aranda & Vaquera, 2015). Moreover, researchers have documented through qualitative research how IEP create disparities in these groups, particularly among Latino and Mexican-origin persons (Aranda, Menjívar, & Donato, 2014; Dreby, 2015; Suro, Suárez-Orozco, & Canizales, 2015). Indirectly, some states also restrict unauthorized immigrants from participating in publicly-funded programs, which may restrain mixed-status families, or families with at least one unauthorized immigrant, from regularizing their status and achieving economic mobility (Yoshikawa et al., 2008; Dreby, 2015; Suro et al., 2015). IEP may also further marginalize Latinos and Mexican-origin persons who are living with an unauthorized family member, or are unauthorized themselves, by removing them from support systems and social networks that help most people mitigate stress and be resilient in the face of adversity.

A growing body of research also documents the relationship between IEP and self-appraised physical and mental health. Aranda and Vaquera (2015) demonstrate that immigration enforcement practices produce distress, vulnerability and anxiety among undocumented, immigrant young adults. Fear of detention and deportation is a chronic stressor afflicting documented and US-born Latino and Mexican-origin persons. In a nationwide telephone survey, Latinos who perceived their state's immigration policies as unfavorable had worse self-reported mental and physical health (Vargas, Sanchez, & Juárez, 2017). Lopez et al. (2017) found that both US-born and foreign-born Latinos in Washtenaw County, Michigan reported more immigration enforcement stress and lower self-rated health after an immigration raid in this community. Only one study (Novak, Geronimus, & Martinez-Cardoso, 2017), has employed a quasi-experimental design to demonstrate how one of the largest ICE workplace raids, in Postville, Iowa, was related to increased risk of low birth weight outcomes in infants born to US-born and foreign-born Latinas. Moreover, research from education and child development demonstrate how Latino parents' legal vulnerability directly and indirectly shapes the socioecological context that children in mixed-status families experience (Suárez-Orozco, Yoshikawa, Teranishi & Suárez-Orozco, 2011; Brabeck, Sibley, & Lykes, 2016).

In Arizona, where the present study takes place, Senate Bill 1070 "Support Our Law Enforcement and Safe Neighborhoods Act," (SB 1070) was passed in 2010. This state policy allows local law enforcement to arrest persons they suspect to be unauthorized immigrants during lawful stops and detentions (Magaña & Lee, 2013). However, it is important to note that increasing police surveillance of Latino communities and restricting mixed-status families to public programs and services have been evolving since the Illegal Immigration Reform and Immigrant Responsibility Act of 1996. In fact, even a decade before the passage of SB 1070, there were several policies that limited the ability for unauthorized immigrants to enroll in welfare programs, work, obtain bail, file a lawsuit, or pay in-state tuition (see Magaña & Lee, 2013 for review).

The implementation of SB 1070 has been linked to negative psychosocial health among documented and undocumented Latinos in Phoenix (Skupinski-Quiroga, Medina & Glick, 2014; Moya-Salas, Ayón, & Gurrola, 2013). Romero's (2006, 2011) ethnographic and archival research of the "Chandler[2] Roundup of 1997" powerfully demonstrate how mostly Mexican-origin children and adults, in their most mundane activities, were accosted by Chandler police to show their proof of legal presence in the US, without actually engaging in any criminal activity.

Despite these important advances, little research examines the relationship between fear of deportation (FOD) and biobehavioral health outcomes in Mexican-origin or mixed-status families (except Landale, Hardie, Oropesa & Hillemeier, 2015). This study attempts to address this gap by applying a biopsychosocial (Clark, Andersen, Clark & Williams, 2012; Harrell, 2011) and socioecological approach (Bronfenbrenner & Morris 2006; Suárez-Orozco et al., 2011) from the embodiment of racism paradigm (Gravlee, 2009; Kreiger, 2005; 2012) to examine how household fear of deportation is related to salivary proinflammatory cytokines (interleukin-1β [IL-1β], interleukin-6 [IL-6], interleukin-8 [IL-8] and tumor necrosis factor alpha [TNFα]), proxies for oral inflammation, in Mexican-origin families living in Phoenix in 2014–2015. To the best of our knowledge, we are one the first to examine how fear of IEP are related to physiological health outcomes, specifically oral inflammation, in Mexican-origin mixed-status families.

Social Disadvantage and Psychosocial stress: Relation to proinflammatory cytokines We focus on oral inflammation because it is an important indicator and predictor of oral health (Chaffee & Weston, 2010; Humphrey, Fu, Buckley, Freeman & Helfand, 2008), immune function (Riis, Granger, Minkovitz, Bandeen-Roche, DiPietro & Johnson, 2016) and chronic disease (Kiecolt-Glaser, Preacher, MacCallum, Atkinson, Malarkey & Glaser, 2003). Chronic inflammation in the oral mucosa is associated with risk for illnesses that are highly prevalent in Mexican-origin persons, including cardiovascular disease (Kuo, Polson, & Kang, 2008; Meurman, Sanz, & Janket, 2004; Paster, Olsen, Aas & Dewhirst, 2006) and diabetes (Saremi et al., 2005). The oral mucosal immune compartment has evolved to serve as one of the human body's most important and effective first lines of defense against exposure to a wide range of pathogens, viruses, fungi, toxins, and microbes (see Petersen, Bourgeois, Ogawa, Estupinan-Day & Ndiaye, 2005 for review). Monitoring individual and intra-individual differences in the levels of inflammatory activity in the oral mucosa is of great interest to investigators and clinicians studying risk and resilience for disease and health disparities.

Cytokines are key signaling molecules regulating communication within the immune system, and between the immune system and the endocrine and central nervous systems. They are primarily secreted by lymphoid cells involved in the initiation, amplification, or attenuation of immune activity. They are separated into different families such as interleukins, interferons, growth factors, and tumor necrosis factors, and differ in their sources of secretion and biologic activities (for review, see Dinarello, 2007). Since the saliva to serum correlation of proinflammatory cytokines has not been well established, salivary proinflammatory cytokines primarily represent inflammation in the oral cavity; serum cytokines are a better representation of the body's immune function (Riis, et al., 2014; Riis, Granger, DiPietro, Bandeen-Roche & Johnson, ; 2015; Riis et al. ; 2016; 2017). Nevertheless, salivary cytokines "…may still be strongly predictive of disease and wellbeing" (Slavish, Graham-Engeland, Smyth & Engeland, 2015,

[2] Chandler is a Phoenix suburb. The Chandler Roundup is the name locals give to Operation Restoration, where local Chandler police worked in conjunction with ICE to identify, detain and deport unauthorized immigrants for five days in July 1997. There were not only raids of people's home, but Chandler police on bicycles stopped Latino children, adults and elders they suspected to be unauthorized immigrants for proof of citizenship. Police largely based their suspicions on people's skin color. Those who could not provide proof of legal residence were arrested. Although 432 persons were deported from this operation, there were several citizens and authorized immigrants who were arrested. There were a number of lawsuits filed at the local, state and federal levels for mass ethnic profiling of a Latino community.

p. 267).

Recent studies use salivary proinflammatory cytokines to examine the correlates and concomitants of environmental, systemic, and developmental processes that may have considerable impact on human health. For instance, studies reveal associations between the levels of salivary inflammatory markers and family environment (Byrne et al., 2017a, 2017b), acute stress (Laurent, Lucas, Pierce, Goetz & Granger, 2016; Slavich, Way, Eisenberger & Taylor, 2010; Slavish et al., 2015), sleep (El-Sheikh, Buckhalt, Granger, Erath & Acebo, 2007), depression or other mental health symptoms (Delany et al., 2016; Keller, El-Sheikh, Vaughn & Granger, 2010; Miller, Maletic & Raison, 2009; Riis et al., 2016), and variation in environmental sensitivity of the autonomic and central nervous systems (O'Connor et al., 2009; Riis et al., 2016; Slavich et al., 2010). This emerging literature clearly demonstrates the potential of salivary proinflammatory cytokines to add value in biobehavioral health research.

There have been studies that lead researchers to believe that chronic stress may lead to increased levels of cytokines. Cortisol reduces the production of proinflammatory cytokines, but chronic stress may create biological dysregulation in which there is a decrease in cortisol emitted from the hypothalamic-pituitary-adrenal axis (HPAA). Another potential mechanism for the inverse relationship between chronic stress and cytokines is that chronic stress may hinder the immune system's response to hormonal cues, hence impairing the body's inflammatory response to cortisol (DeSantis et al. 2012; Johnson, Riley, Granger & Riis, 2013).

Embodiment of racism: Biopsychosocial and socioecological approaches

The embodiment of racism refers to a critical re-examination of the way that social scientists have studied race. Although social scientists emphasize that race is a social construction, our scholarship often falls short in changing the essentialist notions of the relationship between biology and race in biomedicine and public health (Gravlee, 2009). Taking an embodiment of racism approach forces us to examine how racial and ethnic social hierarchies shape people's biology, or "gets under their skin" (Gravlee, 2009; Krieger; 2005, 2012). Two approaches to examining the embodiment of racism is through the biopsychosocial and the socioecological approach to racial and ethnic health disparities.

The socioecological approach considers that humans develop in a context where individuals interact with their distal and proximal environments, which are nested within larger systems of the social ecology (Bronfenbrenner & Morris 2006). Socioecological approaches provide a multilevel approach that encourages the study of inter-relationships between society, communities, and organizations to discern how these larger systems shape inter- and intrapersonal health outcomes (Krieger, 2005; Brabeck et al., 2016). The socioecological approach recognizes that even documented and citizen family members experience negative psychological and physical health outcomes from living with one or more unauthorized family members (for review see, Suárez-Orozco et al., 2016). We will examine three levels of the social ecology: 1) the *exosystem*, which refers to the everyday experiences with different organizations such as work, school and government agencies; 2) *microsystems* referring to family contexts and processes in relation to the presence of unauthorized family members; and 3) *individual* representing each family members' body mass index (BMI) z-score and salivary proinflammatory cytokine levels.

The biopsychosocial approach builds on the stress-coping model proposed by Lazarus and Folkman (1984) and Selye's (1976) theory of stress on the HPAA. The biopsychosocial approach posits that there are physiological and psychological responses to stress from experiences of perceived racism (Dressler, Oths and Gravlee, 2005; Harrell et al., 2011; Clark et al., 2012), but also material and political deprivation can result from institutionalized racism that create racial and ethnic health inequalities (Krieger, 2012). Our perspective emphasizes the biobehavioral effects of stress associated with racism from IEP targeting Latino- and Mexican-origin persons.

Current study

The present study examines the relationship between chronic stressors and four salivary proinflammatory cytokines (IL-1β, IL-6, IL-8, TNFα) in Mexican-origin families with at least one immigrant parent. Specifically, we examine how individual- and family-level health outcomes such as salivary proinflammatory cytokines are related to stressors representative of families' interactions with everyday institutions, or those in the exosystem (e.g., Department of Motor Vehicles, government agencies, local police, courts, etc.) and the microsystem (e.g., family conflict and parenting chronic stress). We are especially interested in examining whether household fear of deportation (FOD) has a stronger relationship with salivary proinflammatory cytokines, than economic/occupational, immigration, parental and family conflict chronic stressors. Given qualitative and survey research demonstrating the negative effects of immigration enforcement on persons accosted by police, immigration enforcement agents, and children with unauthorized immigrant parents, household FOD is a chronic stressor that shapes Mexican-origin and Latino families' social ecology, and subsequently, family members' physiological health outcomes. In places like Phoenix, where local law enforcement has been an extension of immigration enforcement for over 25 years, the threat of sudden deportation is present in multiple institutions where police have a constant presence such as schools, healthcare facilities, social service agencies, and courthouses.

Methods

Sample and design

This was a cross-sectional, exploratory study obtaining anthropometric, demographic, psychosocial, and salivary data from families with at least one Latina/o immigrant parent. Although we initially sought to recruit multiple nationalities, all families that agreed to participate were Mexican-origin. The Southwestern United States' Latino population is primarily Mexican-origin. We recruited families utilizing a cluster probability sample, in which we conducted a simple random selection of 30 census tracts with a high location quotient of foreign-born Hispanics/Latinos between 1.8–3.5 (range 0.4–3.6) based on the 2010 US Census Data for the City of Phoenix. Data collection occurred in the summer/fall of 2014 in Phoenix AZ. More detailed description of the recruitment of families for this study can be found in other publications (Martínez, Ruelas, & Granger, 2017a; 2017b).

Families were able to participate in the study if they self-identified as Hispanic/Latino families, lived in the City of Phoenix, and had at least one parent who was an immigrant from a Spanish-speaking, Latin American country. We excluded families from participating in this study if the head of household was under 18 years of age or was incapable of providing consent for themselves or their children. For the validity of the saliva analytes, following recommendations by Granger and colleagues (2012), we excluded families who had a family member that: just visited the dentist in the last 24 hours; smoked or chewed tobacco; had open mouth sores or abrasions; ill with an acute condition or chronic disease; or a had a fever.

Measures

We used salivary analytes to assess our main outcome variables, proinflammatory cytokines (IL-1β, IL-6, IL-8, TNFα) as proxies for oral inflammation. We collected 1.0–1.8 ml of whole, unstimulated saliva (< 1 teaspoon) from each family member between 14:00-17:00 P.M. to account for the diurnal patterns of IL-6. Adults and children > 6 years provided whole saliva using the passive drool technique (Granger,

Hibel, Fortunato & Kapelewski, 2009). Children between the ages of 0–5 sat on their parent's lap, while the research assistant held a polyolfin absorbent swab (Salivabio, Carlsbad, CA) in their mouth for three minutes. Participants could not have eaten food, drank liquids (other than water) or brushed their teeth within an hour of providing sample (Granger, Fortunato, Beltzer, Virag, Bright & Out, 2012). The saliva was expressed from the absorbent swab by compression using a needleless syringe into a 2.0 ml cryovial on site. The procedure was repeated until the sample volume reached 1.8 ml. Samples were immediately stored and transported it in a cooler with dry ice. At the end of each day of field work, participants' de-identified saliva samples were stored at -80 °C.

Following Riis and colleagues (2014; 2015; 2016; 2017), salivary cytokines were measured using 96-well format multiplex electrochemiluminescence immunoassays manufactured by Meso Scale Discovery (MSD, Gaithersburg, MD). Distinct spots within each well of a 96-well plate were coated with capture antibodies specific to the four cytokines (TNFα, IL-1β, IL-6, IL-8). Detection antibodies were conjugated to SULFOTAG^{TM} labels that emit light when electrochemically stimulated via carbon-coated electrodes in the bottom of each microwell. The MSD 4-plex Multi-Spot Array assay was run following the manufacturer's recommended protocol without modification using standard diluent (MSD # R51BB). Concentrations (pg/mL) were determined with MSD Discovery Workbench Software (v. 3.0.17) using curve fit models (4-PL with a weighting function option of $1/y^2$). Lower limits of detection in the MSD multiplex cytokine assay system for IL-1β, IL-6, IL-8, and TNFα ranged between 0.08 and 0.20 pg/mL. On average intra-assay and inter-assay coefficients of variation were less than 5% and 10%, respectively.

After collecting the saliva samples, we measured each family member's weight with a SECA 876 Portable Scale and their height with a SECA Portable stadiometer. Infants were measured recumbent for length. We also measured the smallest part of their waist and the widest part of their hips with a Gulick II measuring tape. All measures were recorded in metric units. The participants took off shoes and heavy garments before being weighed or measured. After collecting the salivary and anthropometric data, we completed a tablet-based interviewer-administered family questionnaire in the language of their choice. The majority (26/30) were conducted exclusively in Spanish and the items were primarily answered by the head of household, but we also solicited the responses of other family members for the psychosocial measures that we modified as family-level measures (see below). The entire home visit took 2–3 h. The university Institutional Review Board approved this study.

Chronic stressors

The Hispanic Immigrant Stress Inventory (HISI) Short Form (Cervantes, Padilla, & Salgado de Snyder, 1991) was used to assess chronic stressors and the family's perception of the severity of those stressors. The scale assesses five dimensions of stress including stressors from being an immigrant, parenting, marital stress, economic/occupational stress, and family conflict. There are 16 items in this scale in which we ask if the person or someone in their family has experienced that stressor in the last three months and then how worried/tensed they felt from that event. The stress severity was evaluated on a 5-point Likert scale from Not Worried/Tense = 1 to Extremely worried/tense = 5. This scale had high internal consistency at $\alpha = 0.83$.

A confirmatory factor analysis revealed that the families' responses to the items loaded onto each of the dimensions of the scale (i.e., economic/occupational, immigration, family conflict and parental chronic stress). We omitted one item from the family conflict chronic stress factor, "There has been violence among members of our family," and one item from the parental chronic stress factor, "My children have talked about leaving home," as only one family responded in the affirmative to each item (See Table 5). There was only one item in the short form to assess marital chronic stress, since it was not strongly related to household FOD or the salivary cytokines, we excluded this item from the final analyses, too.

Table 1
Fear of Deportation Questionnaire: Exploratory Factor Analysis[a] n = 30 heads of household.

	Factor 1	Factor 2	Factor 3	Uniqueness
Walking in public	0.85	−0.05	−0.004	0.28
Seeking help from government agencies	0.55	0.41	−0.02	0.53
Reporting incidents to the police	0.69	0.32	0.06	0.42
Reporting personal incidents to police	0.67	−0.15	0.03	0.53
Reporting to court (even with a summons)	0.85	−0.05	−0.004	0.28
Obtaining a driver's license	−0.20	0.46	−0.05	0.75
Waiting at the corner for work	−0.06	0.57	0.02	0.67
Factor	**Variance**	**Difference**	**Proportion**	**Cumulative**
Factor 1	2.69	1.86203	0.8997	0.90
Factor 2	0.83	0.82199	0.2773	1.18
Factor 3	0.007	.	0.0025	1.18

LR test: independent vs. saturated: chi^2 (21) = 284.52 Prob > chi^2 = 0.0000
[a] Principal components factor analysis with orthogonal rotation results shown here

Fear of deportation

To assess FOD at the household level, we used an existing seven-item, Fear of Deportation Questionnaire ($\alpha = 0.70$), created by Arbona and colleagues (2010). This questionnaire discerns if the respondent avoided seeking government services, attending court, reporting crimes done onto others or oneself, or being in public for fear of deportation. Every affirmative answer receives a point (0 = no avoidance of the activity for fear of deportation/1 = avoidance of the activity for fear of deportation) with a maximum score of seven. Arbona and colleagues sampled mostly Mexican and some Central American immigrants from two major cities in Texas. Arizona and Texas share parallel history of US conquest and similar demographics, as they are Southwestern borderland states with a strong presence of Mexican Americans and border patrol. Given that our sample in Phoenix is similar to the one in Arbona and colleagues' study, this questionnaire was culturally-appropriate.

Arbona and colleagues' (2010) only provided the Kuder-Richardson-20 reliability coefficient ($\alpha = 0.91$). Below, we include results from an exploratory factor analysis (EFA; see Table 1) using principal components factor analysis with an orthogonal rotation to demonstrate validity of the questionnaire with this sample. Results indicate that the items have factor loadings (≥0.46) that largely fall on two factors: the first factor explains 90% and the second factor explains 28% of the variance, respectively. We decided to use the fear of deportation summative score in the final models (similar to Arbona and colleagues), versus a categorical latent variable because the second factor only included two items, "obtaining a driver's license" and "waiting at the corner for work," which loaded onto one factor; however, each factor should have at least three variables (Brown, 2014).

We modified both Arbona and colleagues (2010) FOD Questionnaire and the HISI (Cervantes et al., 1991) to family-level measures by asking whether the respondent or someone in their family engaged in those activities or felt a certain way during a scenario. For example, "*Have you or someone in your family* avoided asking for help from government agencies for fear of being deported?" In the introductory prompt for the HISI Short Scale and the Household FOD Questionnaire we told families, "Please let me know if the following situations have occurred *to you or your family* at least twice during the last three months."

The other survey items queried family composition, language preference at home, work and school for all family members, the self-rated

health of the head of household and of each family member, health insurance status of all family members and the family's barriers to health care. The head of household's current employment status, highest education level, and literacy were inquired. We also asked if the family rented or owned their current residence.

In order to assess the family's ancestry, we first asked the head of household their country of origin and that of their immigrant family members. We modified the race item on the survey by not only including the four US Office of Management and Budget categories, such as "White non-Hispanic," but also the categories from the Spanish caste system, which takes into consideration racial miscegenation. For example, White and Black persons self-identify as Mulatta/o or those who identify with White and Indian identified as Mestizo. We do not support biological constructions of race, and agree the caste categories are problematic relics from Spanish colonialism that assume discrete racial categories (Candelario, 2004). However, for the statistical purposes of this study and the importance that race plays in profiling for IEP, it was important to include items that the participants recognized.

Analytic strategy

The four, individual mean salivary proinflammatory cytokine levels were positively skewed, so we used a natural log transformation for statistics where a normal distribution was needed. We calculated a correlation matrix between the covariates and each salivary proinflammatory cytokine. We conducted a confirmatory factor analysis (CFA) of the HISI Short Form to compare our factor loadings to that of Cervantes and colleagues (1991). We created a four-plex cytokine latent variable to consolidate the different proinflammatory cytokine analytes of each family member (four-plex: IL-1β; IL-6, IL-8, TNFα; See Fig. 1) into one outcome variable that captured local-oral inflammation. Then, we estimated a CFA measurement model of our multilevel structural equation model to examine the relationship between the psychosocial latent variables and the four-plex cytokine latent variable (See Fig. 1).

We estimated random effects multilevel structural equation models (MSEM) using full information maximum likelihood (Enders, 2010) to adjust for the lack of independence between family members and

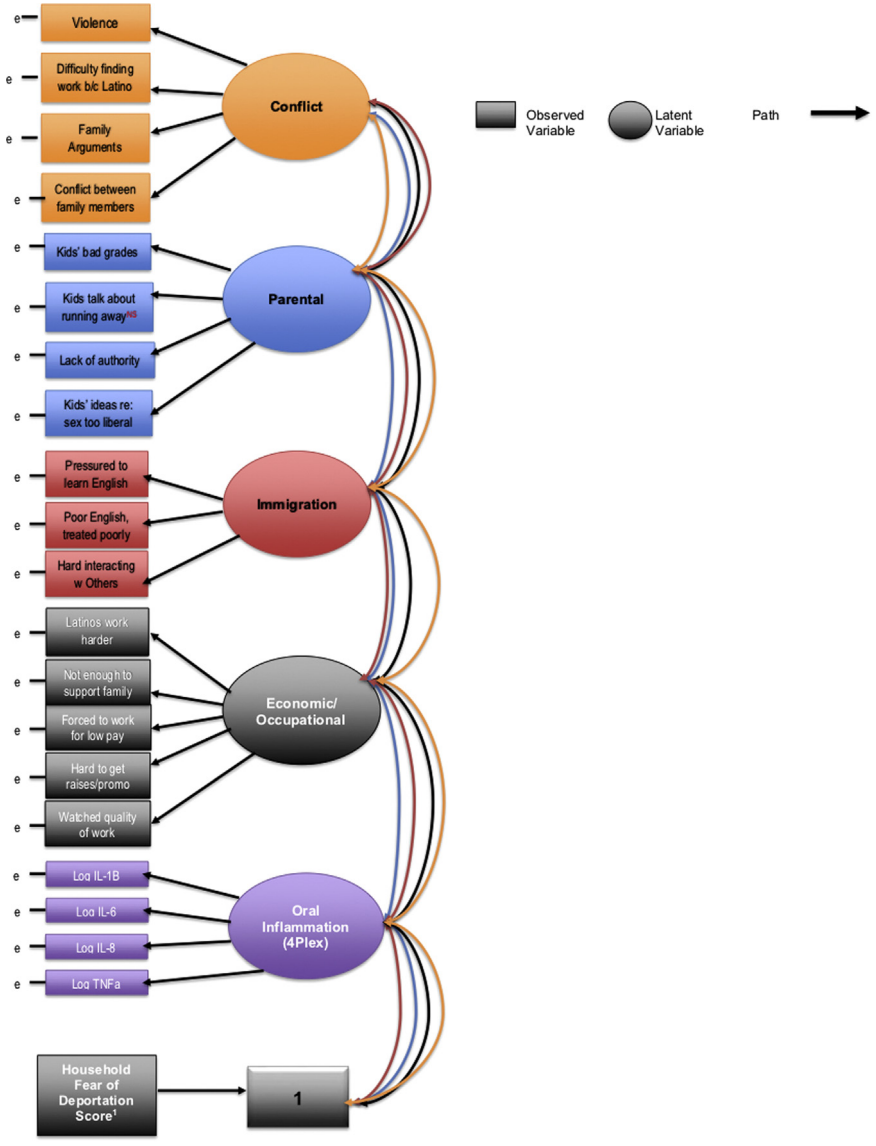

Fig. 1. Confirmatory Factor Analysis between Household Fear of Deportation, the Hispanic Immigrant Stress Inventory Short Form Dimensions & the four-plex cytokines latent variable (Between Families).

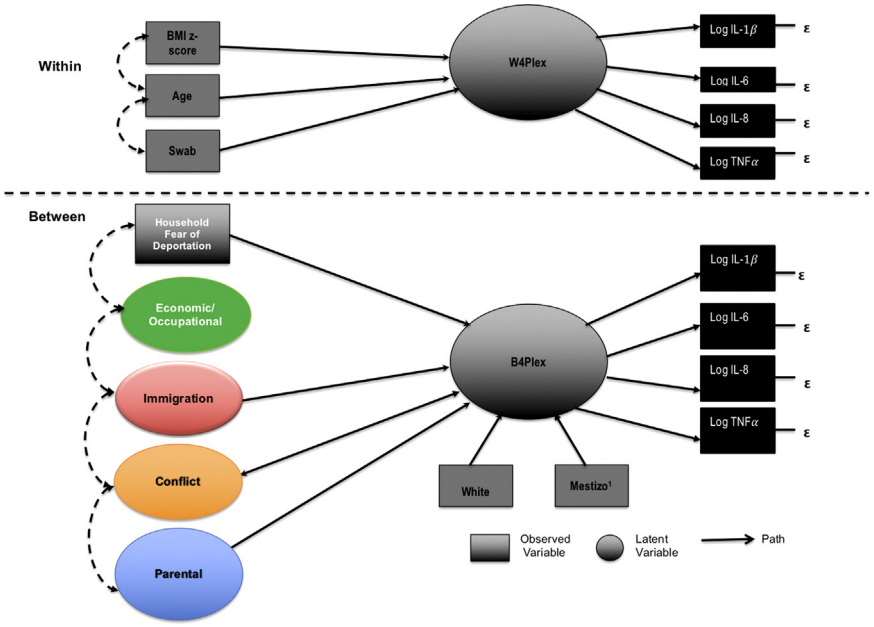

Fig. 2. Multilevel Structural Equation Model: Examining differences within and between Mexican-origin mixed-status families' four-plex cytokine latent variable.

Table 2
Family demographic and chronic stress characteristics, n = 30.

Family Size [R, (M)]	2–8 persons (4.2)
Number of Children	1–6 children (2.3)
Years in USA [M ± SD]	10.69 ± 7.49
Years in Phoenix	9.91 ± 6.75
Race	
White (White)	7 (23.3%)
Moreno (Dark Features, Light Skin)	5 (16.7%)
Mestizo (Indian & White)	11 (36.7%)
Zambo (Black & Indian)	7 (23.3%)
Marital Status[a]	
Married	23
Living w/ partner	3
Divorced/Separated	4
Annual Family Income	
< $20,000	16 (53.3%)
$20,000-$34,999	11 (36.7%)
$35,000-$49,999	3 (10.0%)
Home Ownership	
Rent	28 (93.3%)
Own	2 (6.7%)
Fear of Deportation[b] [N (%)]	
Walking in public	2 (6.7%)
Seeking help from government agencies	4 (13.3%)
Reporting incidents to the police	3 (10%)
Reporting personal incidents to police	3 (10%)
Reporting to court (even with a summons)	2 (6.7%)
Obtaining a driver's license	7 (23.3%)
Waiting at the corner for work	3 (10%)
Had ≥1 fear	14 families (47%)
HISI Stress Dimensions[c] [N (%)]	
Chronic Economic/Occupational Stress	8 (27%)
Immigration Stress	10 (33%)
Family Conflict Stress	11 (37%)
Parental Stress	6 (20%)

[a] Based on 30 heads of household
[b] Fear of Deportation Questionnaire (Arbona, Olvera, Rodriguez, Hagan, Linares & Wiesner, 2010) has **Yes/No** responses
[c] Hispanic Immigrant Stress Inventory (Cervantes et al., 1991) had a 5-point Likert scale. Here, we report the number of families reporting *Moderately stressful/tense* to *Extremely stressful/tense*

because we lack prior knowledge of the effect sizes of these four salivary proinflammatory cytokines in the population. The intraclass correlation for each salivary cytokine was between 0.256 (IL-1β) and 0.568 (TNFα) indicating that proinflammatory cytokine levels cluster by family membership, supporting the need to examine the family as the unit of analysis. Due to the sampling method, it is possible that there is clustering at the census tract level, however, we do not meet the minimum number of clusters (≥ 25) for a meaningful analysis (Kreft & De Leeuw, 1998; Wolf, Harrington, Clark & Miller, 2013). Due to our small sample size, the fit between the model and observed data was acceptable if the comparative fit index (CFI) was greater than 0.90 (Bollen & Long, 1992), the Root Mean Square Error of Approximation (RMSEA) was at or below 0.08 (MacCallum, Browne & Sugawara, 1996); and the Standardized Root Mean Square Residual (SRMR) was equal to or less than 0.08 (Hu & Bentler, 1999). Descriptive statistics were conducted using Stata 12.1 and multilevel structural equation models were estimated using MPlus 7.2.

In our conceptual model, the first level of the MSEM estimates the relationship between BMI z-scores, age, swab use and the individual's mean four-plex cytokine latent variable. Overweight/obesity is a form of low-grade inflammation, we controlled for individual BMI z-scores at the individual level. BMI z-scores were age-and-gender-specific and designated according to the Centers for Disease Control (Kuczmarski et al., 2000). Since BMI z-scores are standardized values for each individual's age category, they are comparable across persons and can be analyzed as continuous variables (Wang & Chen, 2012). We also controlled for the use of a swab (0 = no/1 = yes) at the individual level because it is possible that the concentration of proinflammatory cytokines is influenced when samples are collected using absorbent materials (Granger et al., 2009; Granger et al., 2012). At the second level, we estimated household FOD in relation to each family's mean four-plex cytokine latent variable, while controlling the HISI chronic stressor dimensions and the family's racial identification (see Fig. 2).

Participants

Participants (N = 111) were members of 30 Mexican-origin, low-income families where 53.3% reported an annual family income of < $20,000/year. There were 65 females and 46 males. Sixty-five participants were children (2 months-17 years, 49% female) and 46

Table 3
Anthropometric measures and salivary analyte levels by age category and gender, N = 111.

Age	< 2 years		2–5 years		6–12 years		13–18 years		19+ years	
Gender	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
n	4	3	9	12	12	12	8	5	14	32
BMI (kg/m^2) [M ± SD] (Range)	18.34 ± 4.00 (16.0–24.3)	18.34 ± 2.55 (15.4–20.1)	15.94 ± 1.57 (13.8–18.3)	18.44 ± 3.64 (13.1–25.8)	20.05 ± 5.26 (14.3–32.2)	19.08 ± 4.63 (15.4–31.2)	23.5 ± 5.80 (18.8–37.1)	20.98 ± 3.84 (16.4–25.8)	29.98 ± 2.37[1] (26.3–34.9)	32.51 ± 7.76 (20.1–50)
Waist:Hip(cm) [M ± SD] (Range)	0.99 ± 0.04 (.932–1.02)	0.96 ± 0.03 (.927–0.98)	0.95 ± 0.05 (0.89–1.03)	0.95 ± 0.06 (0.86–1.06)	0.92 ± 0.07 (0.79–1.02)	0.87 ± 0.05 (0.79–0.99)	0.91 ± 0.07 (0.79–0.98)	0.86 ± 0.04 (0.81–0.90)	0.97 ± 0.04 (0.92–1.06)	0.87 ± 0.06 (0.69–1.02)
IL-1β (pg/mL) [M ± SD] (Range)	3.59 ± 0.62 (3.01–4.23)	3.63 ± 1.48 (2.07–5.65)	3.42 ± 1.00 (2.03–4.94)	2.89 ± 1.44 (-0.75–4.77)	4.31 ± 0.86 (2.80–5.63)	3.76 ± 0.82 (2.47–5.19)	3.87 ± 0.99 (2.94–5.82)	3.80 ± 0.62 (3.12–4.47)	4.75 ± 1.99 (0.12–6.93)	4.29 ± 1.28 (1.42–6.75)
IL-6(pg/mL) [M ± SD] (Range)	0.36 ± 0.69 (-0.44–0.83)	1.53 ± 0.69 (0.53–2.08)	1.15 ± 0.98 (-0.36–2.83)	1.00 ± 1.33 (-0.66–3.47)	1.77 ± 1.19 (-0.19–3.77)	1.89 ± 0.99 (0.37–3.28)	0.86 ± 0.69 (0.16–2.11)	1.12 ± 1.06 (-0.8–2.66)	1.45 ± 1.55 (-1.49–4.22)	1.59 ± 1.37 (-0.79–5.42)
IL-8(pg/mL) [M ± SD] (Range)	5.94 ± 0.43 (5.54–6.39)	6.92 ± 1.81 (5.35–9.24)	6.74 ± 0.86 (5.67–8.10)	6.23 ± 1.08 (3.63–8.17)	6.67 ± 0.69 (5.54–7.88)	6.84 ± 0.78 (5.40–7.71)	6.21 ± 0.67 (5.39–7.35)	6.42 ± 0.80 (5.36–7.41)	6.71 ± 1.44 (3.26–8.84)	6.89 ± 0.91 (4.79–8.39)
TNFα (pg/mL) [M ± SD] (Range)	0.01 ± 1.11 (-0.97–1.21)	0.10 ± 1.27 (-1.01–1.86)	0.19 ± 1.09 (-1.30–1.99)	-0.28 ± 0.37 (-1.02-0.15)	0.55 ± 0.51 (-0.54–1.22)	0.43 ± 0.97 (-1.18–1.41)	-0.27 ± 0.71 (-1.32- .69)	-0.35 ± 0.96 (-1.43-0.64)	0.39 ± 0.94 (-1.33–2.16)	0.16 ± 1.05 (-1.75–2.51)

Descriptive statistics calculated in Stata 12.1
Body Mass Index (BMI)
M (Male) F (Female)
1. N = 12
2. N = 11
3 CDC/NCHS age-sex-specific growth charts youth 2–20 years of age, available at: http://www.cdc.gov/nccdphp/dnpa/growthcharts/training/modules/module2/text/module2print.pdf
4. Adult BMI percentiles based on NHANES 2007–2008 data available at: https://www.cdc.gov/nchs/data/hestat/obesity_adult_07_08/obesity_adult_07_08.pdf

Table 4
Correlations between log mean IL-1β, IL-6, IL-8, TNFFa and the study covariates.

	1	2	3	4	5	6	7	8	9	10
1. **LIL-1β**	–									
2. **LIL-6**	0.51**	–								
3. **LIL-8**	0.69**	0.57**	–							
4. **LTNFα**	0.47**	0.56**	0.75**	–						
5. **BMI z-score**	0.32**	0.16	0.22**	0.13	–					
6. **Age**	0.31**	0.11	0.14	0.06	0.73**	–				
7. **Income**	0.08	-0.04	-0.04	-0.02	0.02	0.09	–			
8. **Un/Employment**[a]	0.03	0.11	0.12	0.09	-0.16	-0.17	-0.30*	–		
9. **Education (Yrs)**	-0.01	-0.22*	-0.05	-0.06	0.13	0.10	0.08	-0.25*	–	
10. **Gender**[b]	0.07	0.07	0.08	-0.07	0.17	0.16	-0.05	-0.05	-0.05	–
11. **White**[b]	-0.18*	-0.25**	-0.24**	-0.45**	0.03	0.16	0.05	0.03	-0.31*	0.11
12. **Moreno**[b]	-0.04	-0.06	0.01	0.02	-0.03	-0.12	-0.12	0. 03	0.07	0.16
13. **Mestizo**[b]	0.16*	0.33**	0.29**	0.37**	0.01	0.05	0.24	-0.13	0.15	-0.15
14. **Zambo**[b]	0.07	-0.05	-0.02	-0.03	-0.01	-0.11	-0.32*	-0.13	0.07	0.05

2. Gender (0 = Male, 1 = Female)
L: log transformation
[a] Employment (0 = Unemployed, 1 = employed ≥20 h/week)
[b] Spearman rank correlations at the family level
** $p < 0.05$,
* $p < 0.10$

adults (20–58 years, 71% female). The typical family size was three-four persons, with the largest family having eight persons. The average number of children in each home was two to three. Most of the families had minors living in the household. The majority of families identified as Mestizo (Indian and White). Fourteen families reported one or more fears of being deported, with obtaining a driver's license being the most commonly reported fear (23.3%) (See Table 2).

Without inquiring directly in our survey, some participants shared with us that they or one member of their household was an unauthorized immigrant. Nineteen of the thirty families were mixed-status households, where at least one unauthorized immigrant family member was living in the household.

Results

Female adults had the highest BMIs (x = 32.51 kg/cm^2). There were

Table 5
Results from confirmatory factor analysis measurement model examining the HISI latent constructs and fear of deportation in relation to the four-plex cytokines latent variable (Between Families).

Observed Variable	Latent Variable	Factor Loading	SE	p
Forced to work in low-paying jobs	Econ/Occ	0.40	0.11	0.001
Hard to get raises/promotions at work	Econ/Occ	0.61	0.09	0.001
Had to monitor the quality of their work so others do not think I am lazy.	Econ/Occ	0.58	0.09	0.001
Latinas/os have to work harder	Econ/Occ	0.86	0.05	0.001
Not enough money to support their family or themselves.	Econ/Occ	0.69	0.09	0.001
Because of my poor English, I am treated badly	Immigration	0.72	0.12	0.001
Pressured to learn English	Immigration	0.26	0.18	0.15
Because I do not know enough English, it is hard to relate to others.	Immigration	0.79	0.11	0.001
Kids talk about running away[d]	Parental	0.20	0.22	0.78
I lack authority with my children	Parental	0.60	0.09	0.001
My kids' ideas about sexuality are too liberal	Parental	0.99	0.03	0.001
My children have poor grades in school	Parental	0.80	0.10	0.001
Difficulty finding work because I am Latina/o	Conflict	0.75	0.07	0.001
Arguments in the family	Conflict	0.41	0.13	0.001
Physical violence in the family[d]	Conflict	0.19	0.23	0.67
Conflicts among family members	Conflict	0.63	0.10	0.001
Log IL-1B	4-Plex Cytokine	0.73	0.07	0.001
Log IL-6	4-Plex Cytokine	0.65	0.07	0.001
Log IL-8	4-Plex Cytokine	0.92	0.05	0.001
Log TNFa	4-Plex Cytokine	0.75	0.05	0.001
Fear of Deportation Score	@1			

Covariance Matrix

	1	2	3	4	5	6
1. **Econ/Occ**	–					
2. **Immigration**	0.61***	–				
3. **Parental**	0.63***	0.61***	–			
4. **Conflict**	0.73**	0.81***	0.68***	–		
5. **4-Plex**	-0.12	-0.12	0.07	0.19*	–	
6. **Fear of Deportation**	0.34***	0.47***	0.21*	0.55***	0.19*	–

*** $p < 0.01$,
** $p < 0.05$,
* $p < 0.10$
[d] Omitted from final calculations

Table 6
Random effects multilevel structural equation models of chronic stressors in relation to log salivary cytokines latent variable (L4Plex[c]) in Mexican-origin (n = 111) and mixed-status families [a] (n = 76).

Within Y = L4Plex	Model 1			Model 2			Model 3[a]			Model 4[a]		
	β	SE	p	β	SE	p	β	SE	p	β	SE	p
Swab (0 = no 1 = yes)	0.02	0.11	0.90									
BMI z-score	0.66	0.11	0.001	2.21	2.31	0.34	0.20	0.13	0.12	0.20	0.12	0.08
	Residual Variance											
L4Plex-Oral Inflammation	**0.71**			**0.74**			**0.69**			**0.69**		
IL-1β	0.90			0.80			0.52			0.51		
IL-6	0.68			0.79			0.73			0.73		
IL-8	0.48			0.44			0.25			0.25		
TNF***a***	0.64			0.40			0.19			0.19		
Between[b] Y = L4Plex												
Household Fear of Deportation	0.68	0.34	0.04	0.17	0.07	0.01	0.67	0.10	0.04	0.15	0.03	0.05
Economic/Occupational Stress	-0.66	0.76	0.39	-0.19	0.63	0.003	-0.48	0.15	0.002	-0.24	0.05	0.001
Immigration Chronic Stress	0.11	1.07	0.30	0.03	0.01	0.001	0.10	0.02	0.001			
Family Conflict Chronic Stress	1.96	0.88	0.03	0.11	0.06	0.06	0.99	0.12	0.001	0.26	0.04	0.001
Parental Chronic Stress	-0.20	0.08	0.57	-0.02	0.05	0.65	-0.59	0.05	0.001	-0.12	0.03	0.001
White	-0.10	0.07	0.18	-0.10	0.05	0.06	-0.84	0.33	0.01	-0.25	0.07	0.001
Mestizo	0.62	0.29	0.03	0.23	0.05	0.001	0.37	0.14	0.01	0.21	0.04	0.001
	Residual Variance											
L4Plex-Oral Inflammation	**0.21**			**0.44**			**0.17**			**0.03**		
IL-1β	0.02			0.90			0.01			0.008		
IL-6	0.22			0.03			0.07			0.066		
IL-8	0.06			0.001			0.006			0.007		
TNF***a***	0.02			0.003			0.08			0.09		

β = parameter
p = p-value
SE = standard error
All models estimated using Full Maximum Likelihood with robust standard errors
[a] Model 3 & 4 are 19 families with at least one unauthorized immigrant family member, n = 76.
[b] Between families, as in Fig. 1
[c] IL-1β, IL-6, IL-8, TNF*a*

Table 7
Structural equation model of chronic stressors in relation to log salivary cytokines latent variable[a] (L4Plex) in Mexican-origin heads of household, n = 30.

Y = L4plex	Model 1		
	β	SE	p
BMI z-score	0.39	0.21	0.06
Household Fear of Deportation	0.33	0.18	0.07
Economic/Occupational	-0.01	0.33	0.98
Immigration	0.20	0.20	0.31
Conflict	0.27	0.30	0.37
Parental	-0.07	0.25	0.77
White	-0.07	0.19	0.71
Mestizo	0.12	0.23	0.60
	RV = 0.04		

β = beta coefficient
RV = Residual Variance
SE = standard error
p = p-value
**Model estimated using Full Maximum Likelihood with robust standard errors
[a] IL-1b, IL-6, IL-8, TNFa

no extreme differences detected in the salivary proinflammatory cytokines between age groups (infants < 2, toddlers 2–5, children 6–12, adolescents 13–18, adults 19+ years) (See Table 3 below & Figure 3 in Supplementary Materials). Since there was very little variance in waist-to-hip circumference ratio (0.97 ± 0.04 cm^2), this variable was excluded from the within-level models (see Table 3).

BMI z-score was strongly correlated to IL-1β ($\rho = 0.32$) and IL-8 ($\rho = 0.22$). Age was only related to IL-1β ($\rho = 0.31$). Years of education were marginally related to lower IL-6. Income, gender, or head of household's employment (20+ hours per week) were not related to any of the outcome variables. Families self-identifying as White was related to lower levels of all salivary proinflammatory cytokines. In contrast, higher levels of all salivary proinflammatory cytokines were related to families self-identifying as Mestizo (See Table 4).

Table 5 shows results from the five-factor confirmatory factor analysis (CFA) of the measurement model between families, including how the HISI chronic stress dimensions relate to household FOD and the salivary four-plex cytokine latent variable. We found that all of the latent variables had high factor loadings and low residual variance. The factor loadings for the individual salivary proinflammatory cytokines (IL-1β, IL-6, IL-8, TNFα) are at or above 0.65 and are significant, indicating that we can examine these salivary cytokines as one latent variable representing oral inflammation. We also found that household FOD is strongly related to all of the chronic stressor latent variables from the HISI Short Form. In particular, household FOD was most related to the family conflict chronic stress factor ($\beta = 0.55$, $p < 0.001$). Family conflict and household FOD are both related to the latent variable representing oral inflammation.

The Supplementary materials include the results of multilevel structural equation models (MSEMs) estimating household FOD and HISI chronic stressors in relation to each proinflammatory cytokine. In these results, household FOD or the HISI chronic stressors were not related to IL-1β or TNFα between families, but higher BMI z-scores were related to individual levels of IL-1β ($\beta = 0.85$, $p = 0.001$) and TNFα ($\beta = 0.49$, $p = 0.001$). Higher levels of IL-6 were only related to families reporting more parental chronic stress. Elevated levels of IL-8 between families were related to reporting more economic chronic stress ($\beta = 0.29$, $p = 0.001$) parental chronic stress ($\beta = 0.15$, $p = 0.05$) and household FOD ($\beta = 0.26$, $p = 0.001$). Despite learning this, we estimated MSEMs to examine whether family conflict and household FOD continued to be related to the four-plex cytokines latent variable, while

controlling for other chronic stressors between families and adiposity within individuals.

In Table 6, Model 1 we report results from a comprehensive MSEM, with all 30 families ($n = 111$), examining differences within individual oral inflammation in relationship to swab use and BMI z-scores and differences between family's oral inflammation in relation to household FOD and economic, immigration, parental and family conflict chronic stress. Here, we find BMI z-scores ($\beta = 0.66$, $p = 0.001$) help explain differences within individual family member's four-plex cytokine levels. The use of a swab for saliva collection is not related to lower levels of cytokines ($\beta = 0.02$, $p = 0.90$). At the family level, household FOD ($\beta = 0.68$, $p = 0.04$), family conflict chronic stress ($\beta = 1.96$, $p = 0.03$), and identifying as Mestizo ($\beta = 0.62$, $p = 0.03$) are related to elevated oral inflammation between families. The modification indices from this model recommended omitting the swab variable.

Table 6, Model 2 demonstrates the comprehensive model without the swab use variable. Here, BMI z-score loses its significance ($\beta = 2.21$, $p = 0.34$ vs. $\beta = 0.66$, $p = 0.001$ in Model 1) with individual oral inflammation. It is due to the fact that swab use and BMI z-scores were correlated, but this correlation is a function of age. Younger children provided swab saliva samples and they also have the lowest BMI z-scores in the sample. Between families, household FOD ($\beta = 0.17$, $p = 0.01$) and family conflict ($\beta = 0.11$ $p = 0.06$) continued to be related to higher levels of oral inflammation, albeit marginally for family conflict. Families identifying as Mestizo ($\beta = 0.23$, $p = 0.001$) continued to be related to higher levels of oral inflammation, while families identifying as White ($\beta = -0.10$, $p = 0.06$) was marginally related to lower oral inflammation. Immigration chronic stress became significantly related to four-plex proinflammatory cytokines between families, but the parameter was very small ($\beta = 0.03$). Upon closer inspection of the immigration chronic stress latent variable, not all of the items loaded strongly onto the factor. There was an inverse relationship between oral inflammation and economic/occupational chronic stress ($\beta = -0.19$, $p = 0.003$) between families.

We ran additional analyses to discern whether these results remain consistent among the nineteen families that identified as having at least one unauthorized immigrant family member in the household, i.e., mixed-status families ($n = 76$). Table 6, Model 3 shows results from the comprehensive MSEM without the swab variable, since none of the children in these mixed-status families used a swab for saliva collection. Comparing Models 2 and 3, the main difference between non-mixed and mixed-status families is that the chronic stressors and racial identification had a stronger effect on mixed-status families. For our independent variable of interest, household FOD, the parameter was 0.67, instead of 0.17 with all families. Families reporting more chronic immigration stress ($\beta = 0.10$, $p = 0.001$), family conflict stress ($\beta = 0.99$, $p = 0.001$), and identifying as Mestizo ($\beta = 0.37$, $p = 0.01$) had more oral inflammation. Reporting less chronic economic/occupational stress ($\beta = -0.48$, $p = 0.002$) and families identifying as White ($\beta = -0.84$, $p = 0.01$) continued to have an inverse relationship to oral inflammation. Only among the mixed-status families was reporting less parental chronic stress significantly related to lower oral inflammation. BMI z-scores were not related to differences within family members' four-plex cytokine levels. Modification indices from this model recommended omitting the immigration chronic stress latent variable as not all items loaded strongly onto the factor.

Table 6, Model 4 shows results of a MSEM estimating oral inflammation among mixed-status families without the immigration chronic stress latent variable. As in previous models, household FOD ($\beta = 0.15$, $p = 0.05$), family conflict chronic stress ($\beta = 0.26$, $p = 0.001$), and self-identifying as Mestizo ($\beta = 0.21$, $p = 0.001$) continued to be related to higher levels of the four-plex proinflammatory cytokines in mixed-status families. The omission of the immigration chronic stress latent variable improved the relationship between BMI z-score and proinflammatory cytokines within individuals in mixed-status families ($\beta = 0.20$, $p = 0.08$). This final model had the lowest residual variance ($RV = 0.03$) and the best model fit statistics. One may contend that based on our ancillary analyses of each individual cytokine that the results of our four-plex proinflammatory cytokine latent variable is largely influenced by IL-6 and IL-8. However, examining the residual variance for each cytokine, the model can explain ≥78% of the variance in IL-6, IL-8 and TNFα between families (See Table 6).

One can also argue that the results that we report between families do not represent the correct level of analysis since our psychosocial measures were primarily answered by the heads of household, with input from partners/spouses and older children. As an additional robustness check we have included in Table 7 a structural equation model that examines the HISI chronic stressor latent variables, White and Mestizo racial self-identification, BMI z-score and household FOD (our independent variable) in only the heads of household (HOH; $n = 30$). In this model, we find that white racial self-identification, immigration and family conflict chronic stress are not significantly related to the salivary four-plex cytokine latent variable among HOH. This may be partly due to the fact that the HOH subsample is two-thirds smaller than the total sample. Nevertheless, similar to our MSEMs (Table 6, Model 1 & Model 4), we find that household FOD and BMI z-score are related to higher levels of oral inflammation in the heads of household. Although the *p*-values are marginally significant, the parameters are robust (household FOD: $\beta = 0.68$ vs. $=0.33$/BMI z-score: $\beta = 0.66$ vs. $= 0.39$).

Ancillary analyses examining the relationship between household FOD and each HISI chronic stressor in relation to each proinflammatory cytokine between families do not indicate moderation/mediation of FOD on these other chronic stressors. Only the models estimating household FOD and immigration chronic stress ($B_{FOD} = 0.16$, $p = 0.07$) and household FOD and economic/occupational chronic stress ($B_{FOD} = 0.19$, $p = 0.06$) were marginally significant. These parameters were not very distinct from our parameters in Models 2 and 4 in Table 6. Below we further discuss the interpretation and implications of these results.

Discussion and conclusion

The aim of this study was to integrate socioecological and biopsychosocial approaches from the embodiment of racism to examine household fear of deportation (FOD) in relation to salivary proinflammatory cytokines in Mexican-origin families in Phoenix, AZ post-SB 1070. We estimated multilevel structural equation models to examine these relationships by loading each salivary proinflammatory cytokine onto a latent variable representing local-oral inflammation. From a socioecological perspective, we anticipated that household FOD would be strongly related to more local-oral inflammation in these families because FOD is a stressor emanating from the exosystem, or a set of local and federal policies that shape people's experiences with different institutions such as school, work, police, and government agencies. From a biopsychosocial approach, we expected chronic stress resulting from household FOD to manifest as an inflammatory response in Mexican-origin families. Emerging research suggests that individual variations in salivary proinflammatory cytokines are related to acute psychosocial stress (Laurent et al., 2016; O'Connor et al., 2009; Riis et al., 2016; Slavich et al., 2010; Slavish et al., 2015), but little research has examined this in relation to chronic stress. Depending on the circumstances, salivary proinflammatory cytokines' biological effects may be risk-related or protective for chronic diseases that affect Latinx and Mexican-origin persons, including diabetes and cardiovascular disease, among others.

Our results demonstrate that irrespective of living in a mixed-status household, household FOD and family conflict chronic stress have a strong relationship to oral inflammation in Mexican-origin families living in Phoenix, even after controlling for adiposity and other chronic stressors. However, family conflict stress had a stronger relationship to more oral inflammation than household FOD. The confirmatory factor analysis measurement model indicated that household FOD was

strongly related to each dimension of chronic stress from the Hispanic Immigrant Stress Inventory (occupational/economic, immigration, family conflict and parental chronic stress), but especially family conflict. The barriers to work, constrained movement in public spaces, and constant threat of detention or deportation imposed by immigration enforcement policies and practices may cause strain on all families and uneven division of labor on authorized family members. In mixed-status families, specifically, parental chronic stress was related to lower levels of oral inflammation, possibly because children in mixed-status homes are more cooperative in behaviors that improve family functioning such as language brokering, providing extra income (Chuang & Costigan, 2018) or completing household chores (Fuligni, Telzer, Bower, Irwin, Kiang & Cole, 2009). In contrast, economic/occupational chronic stress was related to less oral inflammation between families.

When comparing our ancillary analyses of each cytokine to the comprehensive MSEMs, household FOD was only related to elevated levels of IL-8, while salivary IL-6 was related to parental chronic stress in these families. These findings suggest that different cytokines could possibly be stressor-specific. For example, a few studies found increased levels of serum IL-1B to be related to social isolation (Pugh et al., 1999; Menachem-Zidon et al., 2008). Another study found that among Mexican women, elevated serum IL-6 was related to reporting more caregiving stress (Gallo et al., 2012). The relationships between the HPAA and the immune system (see Johnson et al., 2013 for review) could help us understand why some of our salivary cytokines were inversely related or unrelated to household FOD.

There are at least three potential pathways that chronic stress could be related to proinflammatory cytokine production. First, chronic stress could create epigenetic changes in systems involved in inflammation and immunity; yet, less is known about the mechanisms that trigger this epigenetic change. In relation to the HPAA and the immune system, the second potential pathway is that chronic stress could cause attenuation of cortisol production or recalibration of the environmental sensitivity of the HPAA. The neuro-endocrine-immune network would be dysregulated and the suppressive effects of cortisol on proinflammatory cytokine production would be compromised. In this scenario, these families have been experiencing chronic stress from fear of immigration enforcement and the elevated levels of oral inflammation we found reflect reduced cortisol production. We assayed for cortisol from our saliva samples, but they were unrelated to the salivary cytokines in this study.

The third potential pathway is that chronic stress could alter glucocorticoid receptor sensitivity on peripheral blood mononuclear cells (Cohen et al., 2012). Glucocorticoid receptor resistance decreases the ability for cortisol to regulate local proinflammatory cytokine production because the suppressive effects of cortisol on immune-lymphoid cells would be dampened, potentially enabling excessive proinflammatory cytokine secretion. There is also research that indicates that proinflammatory cytokines have different temporal responses to stress. For instance, IL-1β initiates the response and production of other proinflammatory cytokines in the presence of stress, injury or infection (see Goshen & Yirmiya, 2009 for review). Longitudinal data would help us better understand the sequence of proinflammatory cytokine production in response to chronic stress.

Families self-identifying as White had less inflammation, while those families identifying as Mestizo had more inflammation. These findings support results from the Multi-ethnic Study on Atherosclerosis (DeSantis et al., 2012) indicating that self-identifying as a racial/ethnic minority was related to higher levels of serum IL-6. Although race in this study was based on self-identification, research on the embodiment of racism from immigration enforcement could be strengthened if we examined how biobehavioral outcomes differs for Latino and Mexican-origin persons who have lighter skin in comparison to those with darker skin. As Romero (2007, 2011) and Armenta (2017) work demonstrates, immigration enforcement policies legitimize local law enforcement's racial profiling of darker Latinos.

Limitations Some of the limitations of this study include the small sample size, lack of longitudinal data, potential selection bias, and the lack of established population means for salivary proinflammatory cytokines in children and adults. Given the smaller sample size, there is a stronger chance of committing a Type II error, where household FOD would have the strongest relationship to families' proinflammatory cytokines. However, we are the first to establish a relationship between fear of immigration enforcement and biobehavioral health. This was a cross-sectional study and we need longitudinal data to ascertain at what point is immigration enforcement an anticipated stressor for members of mixed-status families. One can assume that members of mixed-status families and undocumented immigrants develop strategies in different contexts to anticipate and/or circumvent threats from immigration enforcement. We would need to know how soon after the stress event, such as the detention of family member by ICE, can we expect to observe a change in biological functions and how long these changes persist. Moreover, the implementation of these policies in the US goes through phases depending on parents' and/or children's changing immigration status (e.g., Temporary Protective Status or Deferred Action for Childhood Arrivals) and the local and national political climate towards immigrants.

There is a potential selection bias in our sample because we excluded families if a member of their household had an acute illness or chronic disease. In research examining salivary biomarkers, persons with chronic endocrine disorders are routinely excluded because the function of the systems that produce HPA products, like cortisol, decrease the presence of cytokines. Even acute illness may confound the salivary proinflammatory cytokine levels detected. Although we did not systematically record the reasons why families did not participate, our ethnographic field notes of the study indicate that few families were excluded by the research team. It was more often the case that people refused to participate in the study because they were "not interested" or were "busy." Nevertheless, we would like to pursue a larger sample of households that have family members with acute illnesses and/or chronic conditions to provide a more comprehensive interpretation of the relationship between fear of deportation, chronic stressors, and salivary proinflammatory cytokines.

Flow rates were not collected in study, but we controlled for many of pre-existing factors to consider when assaying for salivary proinflammatory cytokines (Slavish et al., 2015) and used methodological recommendations for saliva collection (Granger et al., 2012). Another potential limitation is the modification of the HISI and the FOD questionnaire to be household-level items. It would have been ideal to ask the other older children and adult family members their chronic stressors and fear of deportation of themselves or other family members, but the logistical coordination of home visits with these families made it difficult to collect psychosocial data from each family member. Nevertheless, our confirmatory factor analyses revealed that the manifest variables were comparable to Cervantes and colleagues' (1991) factor loadings.

Although this study took place in Phoenix, the results should encourage researchers to document the biobehavioral consequences of immigration enforcement and identify the mechanisms that shape the health of mixed-status families in other US cities. For example, in his first few days in office, President Trump issued Executive Order 13767, which reinstated Secure Communities, authorized the building of a militarized wall along the US-Mexico border, and endorsed the deportation of unauthorized immigrants who commit minor infractions. In a recent memo Jefferson B. Sessions III, Attorney General of the Department of Justice, demanded that federal prosecutors charge unauthorized immigrants to the fullest extent of the law by making unlawful presence in the US a felony, instead of a misdemeanor (US Department of Justice, 2017).

Future directions Household FOD could exacerbate the effect of the other chronic stressors in the microsystem, or those experienced in families. Our restricted sample size and the cross-sectional nature of our

data precluded us from conducting an inferential mediation/moderation analysis (MacKinnon, 2008, p. 193–195) that demonstrates whether fear of immigration enforcement modifies the effect of other chronic stressors on oral inflammation. Alternatively, there also warrants future research identifying protective factors and social supports that mediate the effects of household FOD on mixed-status families' inflammation and immune function. Moreover, in order to better understand how chronic stress in the social ecology of immigration enforcement is related to proinflammatory cytokine production, longitudinal studies should explore the mechanistic possibilities of the neuro-endocrine-immune network in mixed- and non-mixed-status families. Lastly, since federal immigration enforcement is selectively implemented in different localities, our future research includes a multi-sited study that compares the biobehavioral and material consequences of immigration enforcement in mixed-status families in different policy contexts.

Our study makes several methodological and substantive contributions to the literature. First, we loaded each salivary proinflammatory cytokine from each family member into a one latent variable, creating a comprehensive measure for oral inflammation at the individual and family level. In relation to the family latent variable for oral inflammation, we learned that individual salivary cytokines clustered by family membership given the high intraclass correlations for each salivary cytokine. Second, we are addressing requests to conduct more research relating salivary inflammatory responses to chronic stress and health. Current research consistently indicates that IL-1β, IL-6 and TNFα increase in saliva in response to acute stress, but less is known about chronic stress in an ecological context (Slavish et al., 2015).

Finally, our research has implications for many disciplines. We are expanding biobehavioral research to identify socioecological mechanisms that may predispose Latino and Mexican-origin persons, particularly children in mixed-status families, to chronic diseases like periodontitis and cardiovascular disease (Meurman et al., 2004; McCurley et al., 2017). We also expand the embodiment of racism, which has rarely examined how racism is embodied in Mexican-origin persons, much less, racism from immigration enforcement. This research also has policy implications by demonstrating that immigration enforcement policies are related to and might later produce negative health outcomes. Monitoring oral health can prevent chronic disease, but it is likely that persons in mixed-status families have limited access to care because of the restrictions to public and private health insurance or limited financial resources. Promoting access to oral care for unauthorized persons and their family could reduce the effects of fear of immigration enforcement on accessing care to prevent or treat chronic disease. When it comes to chronic stress emanating from fear of deportation, health practitioners and social service providers need to consider how this stress can shape the health of citizen and documented members of mixed-status families, especially young children. Lastly, we augment sociological research by demonstrating that fear of immigration enforcement is related to a chronic disease risk, increased oral inflammation, in documented persons and citizens in mixed-status families.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ssmph.2018.06.003.

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