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Stress, Place, and Allostatic Load Among Mexican Immigrant Farmworkers in Oregon

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Abstract Cumulative exposure to chronic stressors has been shown to contribute to immigrants' deteriorating health with more time in US residence. Few studies, however, have examined links among common psychosocial stressors for immigrants (e.g., acculturation-related) and contexts of immigrant settlement for physical health. The study investigated relationships among social stressors, stress buffers (e.g., family support), and allostatic load (AL)—a summary measure of physiological "wear and tear"—among 126 adult Mexican immigrant farm workers. Analyses examined social contributors to AL in two locales: (1) White, English-speaking majority sites, and (2) a Mexican immigrant enclave. Our six-point AL scale incorporated immune, cardiovascular, and metabolic measures. Among men and women, older age predicted higher AL. Among women, lower family support related to higher AL in White majority communities only. Findings suggest that Latino immigrants' cumulative experiences in the US significantly compromise their health, with important differences by community context.

Keywords Allostatic load · Health · Stress · Mexican immigrants · Place · Farm worker · Ethnic enclave

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Introduction

In recent decades, Latino population growth in the United States has exceeded that of all other racial and ethnic groups. Due in part to immigration, mostly from Mexico, this growth has been particularly striking in Oregon and 21 similar states that have limited experience with large influxes of immigrant newcomers [1, 2]. This rapid growth combined with unprepared health and social service systems may heighten stressors in the lives of Mexican immigrants in these states.

Extensive evidence exists that long-term exposure to psychosocial stressors can lead to dysregulation of the body's homeostatic functions [3–6] and eventually to greater wear and tear and impaired health [7]. Allostatic load (AL) represents an attempt to operationalize this process, and is a mechanistically based concept that summarizes dysregulation across multiple physiological systems, including aspects of immune, endocrine, metabolic, and cardiovascular function [3]. Increasingly, research indicates that AL is a powerful tool for the identification of individuals at risk of cognitive decline, disability, and early mortality [5, 8–12]. The measure of AL may be particularly meaningful in studies, such as this one, involving a relatively young sample where few individual measures

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rise to the level of clinical diagnosis [13]; in these instances, a summary indicator may provide a glimpse into pre-disease pathways that establish trajectories of future disease risk.

Research among Latinos suggests that foreign-born individuals have more favorable health profiles (e.g., lower cardiovascular disease prevalence) than do US born. This "healthy immigrant" effect [14–16] is most likely due to selective immigration and to immigrants' practice of protective health behaviors rooted in cultures of origin [17, 18]. Despite initial promising health indicators, cumulative stress exposure as measured by AL appears to contribute to immigrants' deteriorating health over time in the US [19, 20]. This finding remains even when controlling for age, health behaviors, and medical care utilization [19], and has been attributed to chronic psychosocial stress related to acculturation processes (adjustment to life in the US), including exposure to discrimination, poverty, and assimilation pressures, though little AL research to date has investigated these links [20–22]. Some immigrant health studies rely upon individual biological markers, and our own work has investigated links between sociocultural stressors and Latino farmworkers' cardiovascular, metabolic, and immunological function [13, 23–26]. Though this system-specific approach may illuminate the heterogeneity of dysregulation in response to stressors among immigrants, the use of the summative index of AL allows for a more comprehensive view of the impact of stressors across key regulatory systems, and has the added statistical benefit of reducing the chances of type I error [27]. Few immigrant health studies, however, incorporate AL frameworks [21, 22].

Finally, though strong evidence exists of links between racial residential segregation and poor health [28, 29], the effects of ethnic enclaves on residents' health are less conclusive [30–34]. To our knowledge, no study has examined the effects of community context on residents' AL. Researchers have argued that co-ethnic communities may share economic, social and cultural resources [35, 36]. When co-ethnics are immigrants, they may bring with them cultural practices that promote health and discourage risk behaviors [37–39]. Most research on immigrant health, however, has been conducted in traditional immigrant settlement states (e.g., CA, TX, FL, NY, IL, NJ) whose urban centers have dense and historic immigrant communities with diverse institutionalized (e.g., health care centers, churches, civic organizations) and non-institutionalized (e.g., social network) supports. A study of community context and AL may be particularly salient in Oregon, where the recent growth of the Mexican immigrant population has been exponential and highly decentralized [40]. Though there exist a few Mexican origin enclaves, most new arrivals settle in towns unaccustomed to immigrants [35, 38].

To this end, we investigate two research questions: (1) what are the relationships between common psychosocial stressors and AL among Mexican immigrants; and (2) are relationships between stressors and AL different by residential locale? The first question takes the investigation of the acculturation hypothesis one step further by considering the potential influence of family support on AL [22]. The second question explores AL in two contexts with potentially different types and degrees of psychosocial stress exposure for Mexican immigrants. The first setting is a small town with a substantial Mexican immigrant population where embedded social networks and institutions support the maintenance of cultures of origin and engagement in Spanish is possible and functional [41–44]. In the second setting, the majority population is Caucasian, English-speaking, and US born, there is little support for a dual cultural society, and the burden of communication with monolingual English speakers is often borne by immigrants and their children [45, 46].

Methods

Participants

The current project involved collaboration with a well-respected farmworker housing organization. The target convenience sample of 126 immigrant adults ($\geq$18 years of age) was recruited from one of three Willamette Valley farmworker housing locations in: (1) a small White majority rural community (pop. 8,200); (2) a White majority area on the outskirts of one of Oregon's medium-sized cities (pop. 149,000); and (3) within a town (pop. 22,000) that contains an established Mexican origin enclave. The Institutional Review Board at the University of Oregon approved the research protocol and all participants provided written consent prior to the assessment. All respondents were assessed in Spanish.

Approximately 42 % of men and 34 % of women had a third grade education or less, with 7 % of men and 18 % of women completing high school or receiving post-secondary education. Heads of household reported an annual median household income of $16,218 to support an average household of 5 people (SD = 1.5); 93 % of men and 47 % of women were employed, and 37 % of women reported being homemakers.

Measures

In keeping with past research, we quantified AL as a summary measure of function across multiple physiological systems [11, 47]. Our AL variable incorporated six measures including immune function (high-sensitivity

Table 1 Cut-off values (75th percentile) for each parameter of allostatic load

Biological parameters	Highest risk (top quartile)	
	Women	Men
Systolic blood pressure (mmHg)	124.5	127.9
Diastolic blood pressure (mmHg)	79.0	78.8
Waist circumference (cm)	100.5	100.8
Glucose (mg/dL)	90.0	92.0
Total cholesterol (mg/dL)	171.0	168.0
C-reactive protein (mg/l)	2.0	1.4

CRP), cardiovascular function [systolic and diastolic blood pressure (SBP, DBP)], body composition [waist circumference (WC)] and metabolic function (fasting glucose and total cholesterol) (Table 1). Following standard procedures, each measure was computed as a dichotomous variable reflecting either "1" (for highest quartile of risk) or "0" (for all other quartiles) and these variables were summed to create an AL index; cut-off values for each parameter are included in Table 1.

All health measures were recorded using standard procedures (e.g., WC [48]). Blood pressure was measured using an Omron HEM-422CRLC manual inflation oscillometric blood pressure monitor (Vernon Hills, IL), and measured two separate times for each participant. Glucose and total cholesterol concentrations (mg/dL) were obtained from fasted participants using 30 µl samples of capillary blood collected from finger prick and using a CardioChek PA analyzer and PTS Panels (Polymer Technology Systems, Indianapolis, IN). This professional glucose and cholesterol testing system meets standard clinical guidelines for accuracy and precision. High-sensitivity enzyme immunoassay using validated protocols adapted for dried blood spots was used to analyze CRP from dried blood spots on standardized filter paper, with four individuals with current infections (serum equivalent CRP concentrations >5 mg/L) excluded due to acute effects of infection on inflammation [49, 50].

For interview brevity, items were drawn from a larger assessment battery consisting of culturally-specific and standardized instruments described elsewhere [25, 51]. Independent variables included self-reported indicators of annual household income (1 ≤$1,000 to 13 ≥$35,000), highest level of education completed (1 ≤3rd grade to 10 = graduate degree), English language orientation (ELO), time in US residence (TR), age upon arrival, perceived discrimination, and items reflecting two dimensions of Hispanic familism (or feelings of loyalty, reciprocity, and solidarity among family members [54]): perceived family support and family as attitudinal and behavioral referents (Table 2). The ELO factor score was created from three items reflecting respondents' enjoyment of English language activities (e.g., music, TV or radio programs; 1 = don't enjoy to 5 = enjoy very much) and comfort speaking and reading in English (1 = very uncomfortable to 5 = very comfortable) [52]. Higher ELO factor scores reflected greater orientation to English language activities. The Kaiser–Meyer–Olkin (KMO) test of sampling adequacy was 0.637 (considered acceptable); this factor explained 61.3 % of observed variance.

Respondents were asked whether they had been treated as if inferior because of their race, ethnicity, skin color, language, or nationality within the past 3 months, and about their related experience of stress (1 = not at all stressful to 5 = extremely stressful) [53]. Family support was appraised in a (reverse-coded) item that asked participants whether they agreed/disagreed with the statement "when there are problems you should count on family", and family as referents was assessed through the item "family should be consulted about important decisions" (1 = completely disagree to 5 = completely agree) [54]. Potential confounders included age (a continuous variable), smoking (yes/no to having smoked at least 100 cigarettes in lifetime), alcohol use (number of days in past month drank at least one cup of alcohol), food security (1 = food secure; 2 = food insecure without hunger; 3 = food insecure with hunger [55]), current medical insurance, average level of combined back, neck or joint pain (1–10), and average hours of daily TV viewing. We also computed a dichotomous variable reflecting residence within a White dominant locale or within the Mexican origin enclave.

Analyses focused on 126 Mexican immigrant adults (84 females, 42 males). Distributional assumptions were examined using Kolmogorov–Smirnov tests. To ensure a normal distribution for analysis purposes, CRP values were log10-transformed and logCRP used in subsequent analyses (tables include original [non log10-transformed] CRP values for comparison purposes). Student's *t* tests were used to examine differences by sex and place for AL, sociodemographic, lifestyle, and health data (Table 2). Pearson's correlations were used to investigate AL in relation to independent variables of income, education, arrival age, TR, ELO, discrimination, familism, and potential covariates of age, alcohol use, TV, and pain level (Table 3).

Relationships among nearly all significant predictors of AL ($p < .05$) were further examined using ordinal logistic regression (OLR) models (Table 4). For reasons of power, age was chosen in lieu of age upon arrival and years in the US as all variables were significantly correlated for women and men ($p < .01$), and as past studies of AL have focused on age.

For OLR models, all variables were made categorical or dichotomous. We created three-part variables for AL, reversing the scale for easier interpretation (2 = 0; 1 = 1–2;

Table 2 Mean differences in allostatic load, sociodemographic, lifestyle, and health measures (for women and men) and place (for women only)

Variables	Range	$\bar{x}$ (SD)			
		Women ($n = 84$)	Men ($n = 42$)	Women in White majority communities ($n = 50$)	Women in Mexican enclave ($n = 34$)
AL	0–5	1.5 (1.4)	1.5 (1.5)	1.3 (1.3)	1.7 (1.5)
Sociodemographic					
Age (years)	18–73	35.9 (11.7)	38.9 (13.5)	33.8 (10.5)*	38.9 (13.0)
Arrival age (years)	2–63	25.1 (11.1)	23.1 (9.7)	25.5 (11.9)	24.6 (10.0)
TR (years)	0.2–36	9.7 (6.9)**	14.1 (9.6)	7.9 (5.8)**	12.2 (7.5)
Income ($)	<1,000 to >35,000	15,724 (2,454)	16,857 (2,105)	15,724 (2,004)	15,724 (3,325)
Education					
Insured	0–1	0.2 (0.4)	0.4 (0.5)	0.2 (0.4)	0.2 (0.4)
Lifestyle					
ELO	−1.2 to 4.9	0.01 (1.1)	−0.1 (0.8)	0.1 (1.3)	−0.2 (1.0)
Inferior	1–5	1.8 (1.3)	1.8 (1.3)	2.0 (1.3)*	1.5 (1.2)
Support (5 = hi)	1–5	1.8 (1.2)	1.6 (1.0)	1.9 (1.1)	1.7 (1.4)
Decision (5 = hi)	1–5	2.8 (1.4)	2.6 (1.4)	2.7 (1.4)	2.8 (1.5)
Food security (3 = hunger)	1–3	1.7 (0.7)	1.6 (0.6)	1.8 (0.8)	1.5 (0.7)
Days drank alcohol in past month	0–8	0.1 (0.5)***	1.2 (1.8)	0.2 (0.7)	0.1 (0.2)
Ever smoked	0–1	0.02 (0.2)*	0.2 (0.4)	0.02 (0.1)	0.03 (0.2)
Daily TV (hours)	1–7	3.7 (1.3)	3.6 (1.4)	3.5 (1.3)	3.9 (1.2)
Pain level	0–10	6.0 (2.6)	6.6 (1.8)	6.0 (2.3)	6.0 (3.1)
Health					
SBP (mmHg)	89.5–165	112.5 (15.4)*	118.6 (12.4)	110.1 (15.8)†	116.1 (14.5)
DBP (mmHg)	44.5–102	73.8 (9.3)	72.5 (9.0)	72.8 (9.4)	75.2 (9.1)
WC (cm)	63–133	90.5 (13.7)	93.0 (12.6)	89.6 (14.0)	91.7 (13.3)
Glucose (mg/dL)	57–174	85.4 (21.6)	84.2 (18.3)	82.6 (16.7)	86.9 (20.6)
TC (mg/dL)	100–261	148.3 (31.6)	149.8 (34.6)	147.0 (26.4)	150.2 (38.7)
CRP (mg/l)	0.06–4.3	1.6 (1.5)	1.2 (1.3)	1.6 (1.7)	1.6 (1.0)

AL, Allostatic load; Income, annual household income as reported by head of household; Insured, whether have health insurance; TR, time in residency; ELO, English language engagement; Support, family support; Decision, family decision-making; Food, food security; SBP, systolic blood pressure; DBP, diastolic blood pressure; WC, waist circumference; TC, total cholesterol; CRP, C-reactive protein

Student's t tests are statistically significant at † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

0 = 3–6 for women and 3–4 for men). We computed dichotomous variables for age (1 = 35–72 years; 2 = 18–34 years; note: we reversed this variable to simplify interpretation of odds ratios), family support (1 = 1–2; 2 = 3–5), and alcohol use (1 = no use; 2 = any use in the past month). Pearson's Goodness-of-Fit statistics showed that the models for women (.76) and men (.65) were acceptable. Tests of proportional odds assumption were non-significant for each of the models for women and men.

Finally, to explore potential differences by locale, we conducted OLR analyses for each site; as the small sample of men limited our power, we investigated relationships among women only (model B, Table 4). Pearson's Goodness-of-Fit statistics showed that the models for each site (White dominant = .77; Mexican enclave = .09) were acceptable. Tests of proportional odds assumption conducted separately by site for women were non-significant. Model B showed similar results when all four independent variables versus the two significant ones in model A

Table 3 Correlation table for allostatic load for women and men, independent variables, and key covariates

Variables	Women's AL	Men's AL
Income	0.21	0.09
Education	−0.07	−0.28†
Age (years)	0.25*	0.46**
Arrival age (years)	0.20†	0.36*
TR (years)	0.24*	0.15
ELO	−0.02	0.02
Inferior	0.02	0.05
Support	−0.25*	−0.03
Decision	−0.02	−0.30†
Alcohol	−0.02	−0.35*
TV viewing	−0.09	0.04
Food security	−0.14	−0.06
Pain level	0.02	0.21

AL, allostatic load; TR, time in residency; ELO, English language engagement; Support, family support; Decision, family decision-making

Correlations are statistically significant at † $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

Table 4 Ordinal logistic regression models for prediction of (a) allostatic load for women and men, and (b) women in two distinct community contexts

Measure and variables	OR	95 % CI	Pseudo r^2 (Nagelkerke)
A. Allostatic load—women			.18**
Age	2.67	1.13–6.31*	
Alcohol	1.26	.31–5.20	
Support	4.17	1.50–11.54**	
Allostatic load—men			.20*
Age	3.62	1.05–12.51*	
Alcohol	3.71	1.07–12.91*	
Support	.47	.11–2.04	
B. Allostatic load—women in White majority communities			.26**
Age	2.04	.66–6.30	
Support	8.23	2.06–32.92**	
Allostatic load—women in Mexican enclave			.09
Age	3.19	.78–13.10	
Support	1.74	.35–8.53	

OR, Odds radio; CI, confidence interval; Support, family support

* $p < .05$; ** $p < .01$; *** $p < .001$

(women) were included. Thus, the final model B incorporates only two predictor variables for parsimony. All analyses were performed using SPSS 21.0.

Results

Average AL levels were 1.5 for women and 1.5 for men (Table 2), indicating no significant sex differences. Among women, older age, more time in the US, and lower family support were significantly correlated with elevated AL (Table 3). Among men, older age, older age at time of arrival in the US, and lower alcohol consumption were associated with higher AL (Table 3). Older age upon arrival in the US among women, and less education and lower family decision-making among men showed trends in relation to higher AL. AL did not significantly correlate with women or men's income, ELO, discrimination, food security, TV viewing, or pain levels. *T* tests revealed no significant differences in AL between individuals with and without health care access, and smokers versus non-smokers (data not shown). *T* test comparisons by site of women's AL scores and independent variables indicated that women in the Mexican enclave were significantly older (38.9 vs. 33.8 years; $p < .05$), had lived in the US longer (12.2 vs. 8.7 years; $p < .01$), and reported lower discrimination stress (scores of 1.5 vs. 2.0; $p < .05$) than women residing in White dominant sites. Women's AL scores did not significantly differ by site.

Results from OLR models indicated that women with low family support were more than 4 times more likely to have higher AL scores than women with high support; similarly, older women were 2.7 times more likely to have higher AL than younger women (Table 4). Older men and men who reported consuming some alcohol were nearly 4 times more likely to have higher AL scores than younger men and men who reported consuming no alcohol, respectively (Table 4). When OLR models were run separately by site, only *outside* of the Mexican enclave were women with low support more than 8 times more likely to have higher AL than women with high support (Table 4). For women residing within the enclave, no significant predictors of AL emerged.

Discussion

The current study's findings, like those of previous studies, suggest that Latino immigrant men and women's cumulative experiences in the US significantly compromise their health [19, 56]. Results also suggest that AL studies based on national samples may mask important differences by place in the predictors of AL. The finding that low family support was a significant predictor of women's AL outside of the ethnic enclave only, suggests the local nature of certain patterns of health and disease. As in other studies, we failed to identify links between AL and common

acculturation-related stressors (e.g., discrimination, assimilation) [22, 56].

Prospective studies have shown the impact of low social support on life expectancy to be as large as cigarette smoking, hypertension, obesity, and lack of physical activity [57]. Social isolation is generally less prevalent in non-industrialized societies; once in the US, individuals whose social ties have been attenuated through immigration may have smaller social networks—family may provide the main or only support—and experience increased psychosocial stress as a result [58]. Loneliness can chronically activate the stress response, leading to immunosuppression and greater disease risk [59–61].

Despite the widespread recognition that moderate drinking can protect cardiovascular health [62, 63], our finding that more days of consuming alcohol related to men's lowered AL was surprising given the very modest drinking rates reported in this study. Previous researchers have attributed these effects to enhanced insulin sensitivity and reduced inflammation [22, 64], markers incorporated in our AL construct.

The finding that family support and AL were significantly associated only for women living outside the enclave raises questions of whether women are more socially isolated in those communities and thus family support becomes even more salient as a protective factor. This finding also raises questions of whether the enclave and its institutions and networks may buffer otherwise potentially corrosive effects of life in Oregon communities that have few bicultural supports and potentially more intense stressors [44, 45].

This study's findings must be seen in light of its limitations. The small sample size precluded the examination of site differences among men, and findings among both women and men should be replicated with a larger sample. Due to the reliance on a non-probability design, this study's findings may have limited relevance for Mexican immigrants who are not residents of the partnering community-based organization in this study, or who live in other regions of Oregon or the US. The sampling frame raises particular concerns related to selection biases. The sample was composed of farmworkers who may have earned higher incomes, and had more social support than most farmworkers, particularly when compared with workers who live in poor conditions in camps [65, 66]. A more random, representative sample of immigrant farmworkers may document higher psychosocial stress and elevated AL.

The use of a few items from validated instruments may have reduced the variance of responses and influenced results. A more thorough exploration of familism, acculturation, and other forms of social support may provide insights into women and men's physiology and sociocultural worlds. Future studies should assess nutrition and exercise, as well as caregiving, financial, and work strain-related stressors [22, 44], which interrelate with physiological stress and chronic disease risk, and are increasingly incorporated into AL research [67].

New Contribution to the Literature

This study adds to the literature through its novel identification of family support and place as important to Mexican immigrants' AL. Growing evidence documents the interrelationships among individual susceptibility (related to genetic and early developmental influences), individual and community level psychosocial factors, and biologically relevant components of the human environment that can determine health outcomes [67]. Further study is clearly required to identify those elements—from social networks to social contextual stressors to environmental toxins—that may vary by locale in their intensity and impact on immigrants' experiences of aging with effects for AL. Also of future utility is the identification of factors such as family support, and potentially other forms of social support, that may protect against immigrants' higher AL and serve as a target of disease prevention.

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