Social context matters: Ethnicity, discrimination and stress reactivity

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- Cortisol
- Discrimination
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- Latinos
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Abstract

Exposure to chronic discrimination is associated with increased morbidity and mortality. The study of biobehavioral pathways linking discrimination with health outcomes has mostly focused on the cardiovascular system, with fewer studies addressing the hypothalamus-pituitary-adrenal (HPA) axis. In this study we tested associations between Latino ethnicity, experiences of discrimination, and cortisol responses to an acute laboratory stressor. One hundred fifty-eight individuals (92 female, 66 male) between the ages of 18 and 29 years participated in the study. Salivary cortisol was measured once before and eight times after administration of a laboratory stressor (the Trier Social Stress Test). Past experiences of discrimination were measured with the Experiences of Discrimination Scale. Findings from conditional process modeling suggest that Latino ethnicity predicted a) heightened cortisol reactivity and b) more pronounced cortisol recovery through discrimination experiences (mediator), and that this effect was further moderated by sex with a significant indirect effect only among males. The direct path from Latino ethnicity to cortisol reactivity or cortisol recovery was, however, not significant. In sum, findings suggest that Latino ethnicity and discrimination interact to predict cortisol dysregulation, which implies that an appropriate model for understanding minority health discrepancies must incorporate interactive processes and cannot simply rely on the effects of ethnicity or discrimination alone.

1. Social context matters: ethnicity, discrimination and stress reactivity

Discrimination is the unequal treatment of an individual or a group of individuals based on real or perceived differences, and it frequently occurs based on race, age, sex, sexual orientation, gender identity, nationality, religion or disability. Exposure to chronic discrimination has been associated with increased mortality and a wide range of negative physical and mental health outcomes (Paradies et al., 2015; Williams and Mohammed, 2009). Moreover, there is evidence that the stress resulting from discrimination may contribute to health disparities in ethnic minority populations that cannot be accounted for by sociodemographic variables alone (Williams, 1999; Williams and Collins, 1995).

In terms of biobehavioral pathways linking stress from discrimination with disease, the majority of studies have focused on discrimination-related cardiovascular dysregulations and cardiovascular health outcomes (Pascoe and Smart Richman, 2009). The relative lack of research on the role of the hypothalamus-pituitary-adrenal (HPA) system in this context is not just a theoretical omission. In their review of biobehavioral pathways linking discrimination-related stress with disease, Berger and Sarnyai (2015) proposed that stress-related cardiovascular dysregulations primarily result in adverse physical health outcomes, whereas stress-related dysregulations in the HPA system, via their structural and functional changes in brain structures relevant for stress regulation, also contribute to negative mental health outcomes. In fact, many decades of research support the idea that chronic dysregulations in HPA axis function are associated with physical and mental stress-related disease (Chrousos and Gold, 1992), making hormones of the HPA axis a highly relevant research target in the present context.

Briefly, when the HPA axis is activated, the hypothalamus releases corticotrophin-releasing hormone, which stimulates the pituitary gland to release adrenocorticotropic hormone, which then triggers cortisol release from the adrenal cortex; cortisol can bind to receptors on the pituitary, hypothalamus and higher order brain structures, regulating its own activity by a negative feedback system (Tsugos and Chrousos, 2002). The HPA axis is a highly dynamic system characterized by strong diurnal hormonal fluctuations and by its reactivity to acute environmental events, including food intake, exercise and, with particular relevance to the present study, acute stress. It has been argued that individual differences in stress reactivity are reflective of individuals' vulnerability to stress and may explain some of the variability in the link between stress and disease (Boyce et al., 1995; Cohen and Manuck, 2002).
The literature on discrimination and HPA axis responses to acute stressors, which we review in more detail elsewhere (Busse et al., 2017), is small and for the most part reports on changes in cortisol, the end-product of the HPA axis. Studies consistently point toward altered cortisol reactivity with discrimination experiences, but the direction of the effect has varied. One major observation in our review paper (Busse et al., 2017) was that studies inducing experiences of discrimination in the laboratory, typically by using stressors that include elements of discrimination, find more pronounced cortisol responses with discrimination (Hehman and Bugental, 2015; Townsend et al., 2014; Townsend et al., 2011). Conversely, studies comparing cortisol responses between individuals with and without a prior history of discrimination find more blunted responses with discrimination (Hatzenbuehler and McLaughlin, 2014; Jamieson et al., 2013; Richman and Jonassaint, 2008). Similarly, a more recent study showed flattened cortisol responses with internalized racism, a construct related to discrimination, but no association between cortisol reactivity and interpersonal racism was found (Berger et al., 2017).

A second observation concerned possible interactive effects. Some studies are suggestive of interactions between race and discrimination in predicting changes in cortisol reactivity, such that a link between cortisol reactivity and discrimination is found in one ethnicity but not in another (Huynh et al., 2016; Tse et al., 2012; Zeiders et al., 2014). Other studies have shown that discrimination can be associated with altered cortisol reactivity, independent of race (e.g., Skinner et al., 2011) and, conversely, that racial differences in HPA axis activity cannot be solely explained by discrimination experiences (e.g., Martin et al., 2012). At this time, the exact nature of these interactive processes remains poorly understood.

In the present study, we set out to investigate whether living in a social context that is characterized by a high degree of stigma is associated with more frequent experiences of discrimination and, in turn, with HPA axis dysregulation. We studied Latinos, a U.S. group whose members are frequently targets of discrimination. Latinos commonly report being discriminated against by their peers, their teachers, and others based on language skills, immigration status, socioeconomic report being discriminated against by their peers, their teachers, and members are frequently targets of discrimination. Latinos commonly reported being discriminated against in another (Huynh et al., 2016; Tse et al., 2012; Zeiders et al., 2014). Other studies have shown that discrimination can be associated with altered cortisol reactivity, independent of race (e.g., Skinner et al., 2011) and, conversely, that racial differences in HPA axis activity cannot be solely explained by discrimination experiences (e.g., Martin et al., 2012). At this time, the exact nature of these interactive processes remains poorly understood.

In the present study, we set out to investigate whether living in a social context that is characterized by a high degree of stigma is associated with more frequent experiences of discrimination and, in turn, with HPA axis dysregulation. We studied Latinos, a U.S. group whose members are frequently targets of discrimination. Latinos commonly report being discriminated against by their peers, their teachers, and others based on language skills, immigration status, socioeconomic status (SES) and skin color (Edwards and Romero, 2008). We hypothesized first, that being of Latino ethnicity and scoring high on experiences of discrimination would be independently associated with blunted cortisol reactivity; and second, that the association between Latino ethnicity and blunted cortisol reactivity would be mediated by experiences of discrimination.

2. Method

2.1. Participants

The complete study sample consisted of 158 individuals. Fifteen individuals were excluded, four because they reported being half Latino and half non-Latino, and 11 because of missing or insufficient cortisol data. The remaining 143 participants (80 female, 63 male) were between 18 and 29 years old (M = 20.49, SD = 2.08). Of these participants 57.3% reported being Latino, and 42.7% reported being non-Latino (White: 15.4%, Asian: 14.7%, Other: 12.6%). Participants came from various educational backgrounds (college degree, mothers: 25.2%; fathers: 35.7%; middle school or less, mothers: 24.5%; fathers: 21.0%). Mean years of education was 12.24 (SD = 5.38) for mothers and 13.21 for fathers (SD = 5.42). In terms of SES, most participants described their families as lower middle class (43.4%; skilled trade, steady employment), followed by upper middle class (22.4%; professionals, high earned income), upper working class (18.2%; skilled workers, steady employment), and lower working class (16.1%; unskilled workers, employed off-and-on). None of the participants identified their families as upper class (e.g., do not have to work for a living, inherited wealth).

Recruitment occurred among students at the University of California, Irvine and surrounding community colleges. Individuals were excluded from participation if they used medications known to affect cortisol, reported major medical conditions, speech or math phobia, alcohol and drug use, and tobacco use exceeding five cigarettes per day. Of note, none of the participants reported smoking regularly over the past six months.

2.2. Overall procedure

All procedures were approved by the Institutional Review Board of the University of California, Irvine, and all participants provided written informed consent before study procedures commenced. Study days were scheduled to begin at 2pm to control for the significant circadian variation in cortisol secretion.

After a 15-min rest period, a first saliva sample (~2 min) was collected, and participants were escorted to an adjacent room to complete the laboratory stressor (Trier Social Stress Test, TSST; Kirschbaum et al., 1993). The TSST consists of a 5-min mock job interview and a 5-min mental arithmetic task in front of two neutral, non-supportive expert evaluators of diverse ethnicities (e.g., Latino, European, East Asian, mixed background) and both sexes. Including the instruction and preparation period, the TSST lasted 15 min. Upon completion of the TSST, a second saliva sample was collected (+1 min). Participants then returned to the waiting room where additional saliva samples were collected at +10, 20, 30, 45, 60 and 90 min. During this time, participants also completed questionnaires. At the end of the session, participants were thanked, carefully debriefed and awarded their choice of course extra credit or $50.

2.3. Measures

2.3.1. Saliva sampling and cortisol assay

Saliva samples were collected with the Salivette sampling device (Sarstedt, Nümbrecht, Germany), stored at room temperature until completion of the session and then kept at ~70 °C until assayed. After thawing, samples were centrifuged for 10 min at 2000 g and 4 °C. Free cortisol was determined in duplicate by an enzyme immunoassay (IBL-Amercia, Minneapolis, Minnesota). The sensitivity of the assay is 0.033 nmol/L, and the dynamic range is 0–82.77 nmol/L. Inter-and intra-assay coefficients of variance are reported at 4.9% and 4.1%, respectively.

2.3.2. Discrimination

Discrimination experiences were assessed with the Experiences of Discrimination Scale (EOD, Krieger et al., 2005). The EOD contains 9 items about past incidences of discrimination in specific settings, including finding housing, a job, and medical care. Each item is rated based on the frequency of these occurrences over the lifetime (0 = never, 1 = once, 2.5 = two or three times, 5 = four or more times). Individuals are also asked to indicate what category (e.g., race, sex) they consider to be the major reason for the experience of discrimination. The EOD has shown acceptable internal consistency (α = 0.74).

2.3.3. Statistical methods

Summary scores were computed for the EOD, such that higher scores indicated more frequent discrimination experiences. To capture relevant aspects of the salivary cortisol response to the TSST, five summary measures were computed: Cortisol secreted throughout the entire assessment period (pre to +90 min samples) was computed using simple area under the curve computations using zero as a reference line (termed, cortisol AUC). To capture cortisol reactivity, we computed a) the maximum cortisol increase by a participant in response to the TSST by subtracting the pre-TSST cortisol value from the maximum cortisol value obtained at any time after the TSST (+1 min to +90 min samples), and b) the mean cortisol increase by subtracting the pre-TSST...
cortisol value from the average of the first five cortisol values obtained following the TSST (+1 min to +30 min). Similarly, to capture cortisol recovery, we computed a) the maximum cortisol recovery by a participant by subtracting the maximum cortisol value obtained at any time after the TSST (+1 min to 90 min) from the last sample collected (+90 min), and b) the mean cortisol recovery by subtracting the +90 min cortisol value from the average of the first five cortisol values obtained following the TSST (+1 to +30 min). Of note, a stress response score can be negative, if no post-TSST cortisol value is higher than the baseline value, and a cortisol recovery score can be positive, if the +90 min value is higher than all other post-TSST cortisol values. Ethnicity was dummy coded with Latinos coded 1 and non-Latinos coded 0. To test for differences in major study variables between Latinos and non-Latinos, t-tests and \( \chi^2 \)-tests were computed, as appropriate.

Pearson Product Moment Correlations were conducted to obtain an initial impression of associations between variables of interest. Univariate ANOVAs and basic regression models were then conducted to test the ethnicity, discrimination, sex variables and their interactions as predictors of the maximum cortisol increase and recovery. The results from these preliminary analyses guided our selection of moderated mediation models for formal hypothesis testing (model 14 of the PROCESS macro for SPSS, Hayes, 2013). These analyses were conducted with 5000 bootstrap samples to provide indices of the approximate size of the moderated mediation effect at the population level (Hayes, 2015). For ease of interpretation, the scores for all predictor variables were mean centered. Significance for direct and indirect paths were considered significant when the 95% bias-corrected bootstrap confidence interval excluded zero.

3. Results

3.1. Preliminary analyses

In the full sample, past experiences of discrimination were reported by 80.4% of participants. Among those experiencing discrimination, 44.3% reported racial-ethnic factors as the major source of discrimination (race: 34.8%; shade of skin color: 8.7%; ancestry or national origin: 6.1%), followed by age (12.2%), sex (7.8%), education or income level (7.8%), height or weight (6.1%), sexual orientation (2.6%) and Other (13.9%). Reports of discrimination based on racial-ethnic factors were particularly prevalent among Latinos who represented 77% of those experiencing discrimination based on a racial-ethnic factor.

All cortisol summary measures were highly intercorrelated (all \( r > 0.62, p < 0.001 \)), with the highest correlations emerging between the mean and the maximum cortisol increase, \( r = 0.95, p < 0.001 \), and the mean and maximum recovery, \( r = 0.97, p < 0.001 \). Despite these high intercorrelations, only the maximum cortisol increase (\( r = 0.17, p < 0.05 \)) and the maximum cortisol recovery (\( r = -0.19, p < 0.05 \)) were significantly associated with discrimination experiences (\( r = 0.17, p < 0.05 \)), and are thus the cortisol summary measures we included in the models below.

Data were then examined for ethnicity (Latino vs. non-Latino) differences in major sociodemographic variables, and two observations are noteworthy. First, and as detailed in Table 1, Latino participants came from families with significantly lower SES than non-Latino families (all comparisons, \( p < 0.001 \)). When both variables were entered as predictors in a stepwise regression model with discrimination as the outcome variable, only ethnicity emerged as a significant predictor; overall model: \( R^2 = 0.16, F(2142) = 13.57, p < 0.001 \); ethnicity: \( \beta = 0.36, p < 0.001 \); SES: \( \beta = -0.09, p = 0.26 \). Neither variable predicted the maximum cortisol increase, overall model, \( R^2 = 0.066, F(2142) = 0.42, p = 0.66 \); ethnicity: \( \beta = 0.001, p = 0.99 \), SES: \( \beta = -0.08, p = 0.39 \) or the maximum cortisol recovery, overall model, \( R^2 = 0.025, F(2135) = 1.70, p = 0.19 \); ethnicity: \( \beta = -0.167, p = 0.07 \), SES: \( \beta = -0.05, p = 0.61 \). SES was therefore not included in the analyses presented below.\(^1\) A trend toward female participants being over-represented in the Latino sample was also identified (Table 1); sex was therefore further considered in the analyses below.

In a next step, data were examined for ethnicity and sex differences in discrimination and the maximum cortisol increase and recovery scores (see Table 2 for descriptives). Ethnicity, but not sex or the ethnicity by sex interaction predicted discrimination (univariate ANOVA, full model: \( F(3143) = 8.60, p < 0.001 \); ethnicity: \( F(1143) = 24.20, p < 0.001 \)), indicating significantly more discrimination experiences in Latinos compared to non-Latinos. Higher levels of discrimination were associated with a steeper maximum cortisol increase (\( r = 0.17, p < 0.05 \)) and a more pronounced maximum cortisol recovery (\( r = -0.19, p < 0.05 \)) in the overall sample. When stratified by sex and ethnicity, this correlation remained significant only among Latino males (maximum cortisol increase: \( r = 0.43, p < 0.01 \), maximum cortisol recovery: \( r = -0.43, p < 0.01 \); Table 2).

In sum, preliminary analyses suggest that (a) Latinos report more experiences of discrimination than non-Latinos, (b) experiences of discrimination are associated with a more pronounced maximum cortisol increase and recovery only among Latino males, and (c) no direct associations exist between Latino ethnicity and the maximum cortisol increase and recovery. For illustrative purposes, salivary cortisol trajectories stratified by perceived discrimination, ethnicity and sex are depicted in Fig. 1, and show how Latino males’ responses differ from all other groups, in particular for the maximum cortisol increase (Fig. 1c and d). The exact nature of these associations was then tested with moderated mediation models (Model 14; Hayes, 2013).

3.2. Hypothesis testing

Two models were run, one with the maximum cortisol increase and one with the maximum cortisol recovery as the outcome measure. In terms of the maximum cortisol increase, the full moderated mediation model including ethnicity (predictor), discrimination (mediator) and sex (moderator on path from mediator to outcome) explained 6.82% of the variance, \( F(4138) = 2.52, p < 0.05 \) (Fig. 2a). Two significant direct effects were observed: Latinos reported experiencing more

### Table 1

<table>
<thead>
<tr>
<th></th>
<th>Latino M (SD) %</th>
<th>Non-Latino M (SD) %</th>
<th>Group Comparison t-test or ( \chi^2 )-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>% female</td>
<td>48.78</td>
<td>65.57</td>
<td>( \chi^2(1) = 3.35^* )</td>
</tr>
<tr>
<td>Age</td>
<td>20.49 (2.30)</td>
<td>20.49 (1.78)</td>
<td>( t(141) = 0.01 )</td>
</tr>
<tr>
<td>% College Degree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother having</td>
<td>13.4</td>
<td>55.7</td>
<td>( \chi^2(1) = 27.12^*** )</td>
</tr>
<tr>
<td>% Middle School or less</td>
<td>19.5</td>
<td>62.3</td>
<td>( \chi^2(1) = 20.46^*** )</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% lower working</td>
<td>39.0</td>
<td>1.6</td>
<td>( \chi^2(1) = 25.48^*** )</td>
</tr>
<tr>
<td>% higher working</td>
<td>36.6</td>
<td>3.3</td>
<td>( \chi^2(1) = 25.45^*** )</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Mother of father</td>
<td>9.86 (4.88)</td>
<td>15.21 (4.44)</td>
<td>( t(135) = 6.65^*** )</td>
</tr>
<tr>
<td>Age</td>
<td>10.99 (4.86)</td>
<td>15.98 (4.78)</td>
<td>( t(135) = 5.98^*** )</td>
</tr>
<tr>
<td>Family SES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% upper middle class</td>
<td>11.0</td>
<td>37.7</td>
<td>( \chi^2(3) = 18.71^*** )</td>
</tr>
<tr>
<td>% lower middle class</td>
<td>45.1</td>
<td>41.0</td>
<td></td>
</tr>
<tr>
<td>% upper working class</td>
<td>20.7</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>% lower working class</td>
<td>23.2</td>
<td>6.6</td>
<td></td>
</tr>
</tbody>
</table>

Note: \( n = 143 \). * \( p = 0.07 \), *** \( p < 0.001 \).

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\(^1\) When the two full moderated mediation models reported below were run with SES included as a covariate, no significant effects of SES emerged on any path in the model for the maximum cortisol increase (all \( p > 0.24 \) ) or the model for the maximum cortisol recovery (all \( p > 0.48 \)). The overall model using the maximum cortisol increase was no longer significant (\( p = 0.06 \)) Nonetheless, all direct and conditional indirect effects for ethnicity were replicated in both models.
discrimination than non-Latinos ($b = 4.90, SE = 0.96, p < 0.001, CI: 2.99, 6.80$) and higher perceived discrimination was associated with a more pronounced maximum cortisol increase ($b = 1.78, SE = 0.67, p < 0.01, CI: 0.47, 3.10$). In contrast, no direct effect of ethnicity on the maximum cortisol increase was detected, $b = −1.80, SE = 2.83$ ($−7.40, 3.81$).

A conditional indirect effect was observed suggesting that Latino ethnicity predicted the maximum cortisol increase indirectly through discrimination experiences. Further, the path from perceived discrimination to the maximum cortisol increase was moderated by sex, $b = −0.87, SE = 0.42$ ($−1.69, −0.04$). This moderation effect was driven by the male participants, $b = 4.50, SE = 2.12$ ($0.89, 9.33$), not by the female participants, $b = 0.25, SE = 1.73$ ($−2.38, 4.59$), as further confirmed by the non-significant bootstrap index of moderated mediation, $b = −4.25, SE = 2.70$ ($−9.76, 0.92$).

The same moderated mediation model was then run with the maximum cortisol recovery as an outcome, with comparable results (Fig. 2b). The overall model was significant, $F(1141) = 25.63, p < 0.001$, explaining 15.38% of the variance. Similar to the model reported above, two significant direct paths emerged suggesting more perceived discrimination among Latinos ($b = 4.60, SE = 0.91, p < 0.001, CI: 2.80, 6.39$) and a more pronounced cortisol recovery

### Table 2
Means, Standard Deviations, and Intercorrelations. Discrimination as well as Maximum Cortisol Increase and Recovery, Stratified by Ethnicity and Sex.

<table>
<thead>
<tr>
<th></th>
<th>Latino Male (n = 41)</th>
<th>Latino Female (n = 35)</th>
<th>Non-Latino Male (n = 21)</th>
<th>Non-Latino Female (n = 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
</tr>
<tr>
<td>Discrimination</td>
<td>7.26 (6.73)</td>
<td>6.51 (6.94)</td>
<td>3.76 (5.44)</td>
<td>2.55 (3.50)</td>
</tr>
<tr>
<td>Maximum cortisol</td>
<td>14.51</td>
<td>11.96</td>
<td>15.21</td>
<td>11.70</td>
</tr>
<tr>
<td>increase</td>
<td>(16.74)</td>
<td>(14.98)</td>
<td>(13.87)</td>
<td>(16.48)</td>
</tr>
<tr>
<td>Maximum cortisol</td>
<td>−19.51</td>
<td>−13.97</td>
<td>−15.77</td>
<td>−10.77</td>
</tr>
<tr>
<td>recovery</td>
<td>(16.98)</td>
<td>(14.95)</td>
<td>(11.50)</td>
<td>(17.13)</td>
</tr>
<tr>
<td>Discrimination and</td>
<td>.43**</td>
<td>0.04</td>
<td>0.08</td>
<td>−0.07</td>
</tr>
<tr>
<td>maximum cortisol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>increase</td>
<td>Pearson’s $r$</td>
<td>Pearson’s $r$</td>
<td>Pearson’s $r$</td>
<td>Pearson’s $r$</td>
</tr>
<tr>
<td>Discrimination and</td>
<td>−0.41**</td>
<td>−0.08</td>
<td>−0.29</td>
<td>0.11</td>
</tr>
<tr>
<td>maximum cortisol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>recovery</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note: *One-way ANOVA testing differences in discrimination by ethnicity is significant: $F (1142) = 5.89, p = 0.001$; **$p < 0.01$.

Fig. 1. Salivary cortisol responses to the Trier Social Stress Test for participants scoring high vs. low on discrimination (median split). Raw data (mean, SE) stratified by ethnicity and sex for each individual cortisol sample (A, B) and for the change from pre-stress (pre) to the maximum individual time point (max) to the +90 min sample (last; C, D).
with higher perceived discrimination ($b = -2.00$, $SE = 0.68$, $p < 0.01$, $CI: -3.35, -0.65$). Ethnicity did not emerge as a direct predictor of maximum cortisol recovery, $b = -2.51$, $SE = 2.82$, $CI: -8.10, 3.07$.

A conditional indirect effect was identified suggesting that Latino ethnicity predicts maximum cortisol recovery through discrimination experiences, an effect that was further moderated by sex, $b = 1.12$, $SE = 0.44$, $p = 0.01$, $CI: 0.24, 2.00$. This effect was again driven by the male, $b = -4.06$, $SE = 1.77$ ($-8.24, -1.23$), not the female participants, $b = 1.10$, $SE = 1.38$ ($-1.49, 3.91$) although a significant bootstrap index of moderated mediation, $b = 5.15$, $SE = 2.13$ ($1.21, 9.58$) suggests significant differences between males and females.

4. Discussion

The findings of the present study suggest that Latinos are disproportionately exposed to experiences of discrimination which in turn predisposes Latino men to more pronounced cortisol reactivity — a term that we here use to include both the cortisol response and recovery. This mediational relationship was significant only with the individual maximum (not the group-based, mean) cortisol increase and recovery or the area under the cortisol response curve as outcome variables. Of note, the mediational pathway from ethnicity to discrimination and heightened cortisol reactivity emerged in the absence of a direct link between ethnicity and cortisol reactivity. Several findings warrant further discussion.

Two significant direct paths emerged in each model, one from ethnicity to discrimination and the other from discrimination to cortisol reactivity. In isolation, these associations suggest that, as predicted, Latinos experience more discrimination throughout their lifetime than non-Latinos, and that more discrimination experiences are associated with heightened cortisol reactivity. The overarching mediational effects also imply that while discrimination is associated with cortisol reactivity and discrimination is likely the psychological process at stake when considering health consequences, studying it in isolation is not sufficient to capture all processes at play. Social context matters such that Latinos are disproportionately affected by discrimination, putting them at risk for discrimination-related alterations in HPA axis function.

This mediational effect is particularly interesting in light of the absence of a direct association between ethnicity and cortisol reactivity. Even though Latinos in this sample experienced a significantly higher degree of discrimination than non-Latinos, ethnicity alone was not sufficient to predict the changes in cortisol reactivity and recovery that resulted from experiences of discrimination. It appears that using Latino ethnicity as a simple proxy for discrimination may not properly capture the complex social processes driving the association, as has been argued before (Cho, 2006; La Veist, 1996). For example, there is evidence suggesting that Black or dark-skinned Latinos have worse health outcomes than White or light-skinned Latinos (for a review, see Cuevas et al., 2016), and that the more frequent experience of discrimination in darker-skinned Latinos may mediate this association (Perreira and Telles, 2014).

There was also evidence in our data that the mediation effect was moderated by sex, such that the indirect effect was significant only among males. Sex differences in the link between discrimination experiences and stress-related physiological measures and health behaviors have been observed in previous studies (Kershaw et al., 2016; Molina et al., 2016). Moreover, there is both empirical evidence and theory regarding the idea that men and women cope with intergroup conflict differently, and that men are particularly affected by intergroup conflict (Navarrete et al., 2010). In the present context it could also be speculated that men may perceive discrimination experiences as more
dismenowering than women do, or that women may have more access to social support that could buffer the stress associated with experiencing discrimination. In a broader context, this moderational relationship also adds to a growing recognition of intersectionality as an important variable in the discrimination–health link. In the present study discrimination experiences (but not SES) interacted with male sex in predicting cortisol reactivity. The potential risks conferred by sociodemographic factors (e.g., sex, age, SES) or by membership in multiple social groups disproportionally experiencing discrimination (e.g., based on race/ethnicity, sexual orientation, sexual identity, religion, disability), should be further studied by testing the influence of these variables as moderators or mediators in the pathways linking discrimination with health outcomes.

While an association between discrimination experiences and altered cortisol reactivity emerged, as hypothesized, the direction of the effect was not in line with our prediction. Our hypothesis was based on findings from previous biobehavioral studies which we discuss in more detail in our previous review (Busse et al., 2017); those studies typically show more pronounced cortisol responses with acute discrimination (Hehman and Bugental, 2015; Townsend et al., 2014; Townsend et al., 2011) and blunted responses with chronic discrimination (Berger et al., 2017; Hatzenbuehler and McLaughlin, 2014; Jamieson et al., 2013; Richman and Jonassaint, 2008). This pattern of findings is consistent with a large body of work in the broader stress literature suggesting that initially, stress exposure is associated with more pronounced HPA axis responses and over time, as stressors become chronic, HPA axis responses to acute stress become blunted (Miller et al., 2007). Because discrimination experiences are associated with experiences of heightened stress (Huynh and Fuligni, 2010; Magana and Hovey, 2003), conceptualizing discrimination as an acute or chronic psychosocial stressor may be a useful framework for understanding its damaging effects on physical and mental health. In line with this argument, a neurobiological model of racial discrimination posits that ongoing experiences of discrimination result in changes in brain networks associated with heightened stress reactivity, which may ultimately lead to an increased risk of negative mental health outcomes (Berger and Sarnyai, 2015).

However, our present findings do not neatly fit into this pattern. Despite assessing discrimination that occurred over a lifetime, we detected more pronounced cortisol increases and more pronounced cortisol recovery indicating a response pattern more in line with exacerbated, acute stress responses as opposed to blunted cortisol profiles with a less pronounced increase and delayed recovery, indicative of chronic stress exposure (Miller et al., 2007). It may matter how far in the past experiences of discrimination have occurred and how significant the experiences were for the individual. Our sample of undergraduates is still young and it is possible that their experiences of discrimination were either not long-lasting enough or perhaps not yet severe enough to lead to a chronic stress HPA axis profile. Moreover, it is possible that there were other differences between this and previous studies, such as the use of the EOD (Krieger et al., 2005) as a measure of discrimination. The two other studies using a questionnaire measure to compare discrimination with cortisol responses to an acute stressor found an association for structural stigma, but not for perceived discrimination among LGB youth (Hatzenbuehler and McLaughlin, 2014) and for internalized racism but not for interpersonal racism among First Nations People (Berger et al., 2017).

Looking forward, more empirical work is needed to determine the nature of the interactive association between ethnicity and discrimination experiences, in terms of their separate and joint effect on dysregulation in biological systems associated with stress-related disease. Moderators in this association, including but not limited to sex, should also be more systematically addressed. Moreover, there should be further inquiry into the conditions under which discrimination experiences are associated with exaggerated or blunted cortisol responses, and studies specifically assessing the occurrence of recent and more distant, life-time experiences of discrimination would be a good first step. At a minimum, future studies should assess when experiences of discrimination occurred and how significant these experiences were for the individual. Longitudinal, prospective studies are also needed to bring further clarity to this issue. Finally, we studied Latinos living in Southern California, thereby capturing an ethnicity in one social context characterized by disproportionate exposure to discrimination. However, many other social groups are experiencing discrimination, and individuals could be the target of discrimination for more than one trait, raising the possibility of multiplicative effects. In light of the high prevalence of discrimination and the social importance of the link between discrimination and adverse health outcomes, these questions should be addressed in more detail in future research.

In sum, the present study suggests that membership in a stigmatized or marginalized group disproportionately exposes individuals to discrimination, which in turn may impact HPA axis function, in particular among males. These associations represent one possible pathway through which stigma and discrimination may manifest biologically, contributing to health disparities observed among minority populations. A better understanding of the multiple physiological systems that are adversely affected by discrimination is needed. We hope this research is a key step forward in better understanding the role of the HPA system in the pathway linking discrimination with health.

Conflicts of interest

None

Disclosure

Drs. Yim and Campos conceived and designed the overall study and obtained funding. Dr. Busse oversaw data acquisition. All authors contributed to data analyses and interpretation. Dr. Busse drafted the first version of the manuscript and all authors contributed materially to revising it for critical intellectual content. All authors approved the final version of the article.

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