UNIVERSITY OF CALIFORNIA,
IRVINE

The Physiological Costs of Discrimination: Review of the Literature and Empirical Study of the Relationship Between the HPA Axis and Past Experiences of Discrimination

DISSERTATION

submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in Psychology and Social Behavior

by

David Busse

Dissertation Committee:
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DEDICATION

This dissertation is dedicated to Barbara McDermott, research director in the Department of Forensic Psychiatry at the UC Davis School of Medicine. My four years as a research associate for Dr. McDermott was one of the most important and formative experiences in my career as a psychologist.

I would also like to dedicate this to Stephen Lepore. Now a Professor of Public Health at Temple University, he was a professor of Health and Behavior Studies while I was a student at Teachers College, Columbia University. Dr. Lepore sparked my interest in Health Psychology while I was a student in his class, and he recommended that I apply to his former graduate program at UC Irvine.

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ABSTRACT OF THE DISSERTATION

The Physiological Costs of Discrimination: Review of the Literature and Empirical Study of the Relationship Between the HPA Axis and Past Experiences of Discrimination

By

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Doctor of Philosophy in Psychology and Social Behavior

University of California, Irvine, 2017

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Discrimination is a common social problem that that been associated with a variety of negative health consequences. Stress from discrimination experiences and resulting physiological changes have been implicated in the pathway to disease. The role of the hypothalamic-pituitary-adrenal (HPA) axis in this process remains understudied. This dissertation addresses the deficiencies in the literature in two parts. First, a systematic review of the literature was conducted. Ten experimental and 17 observational studies met inclusion criteria. Studies suggest that discrimination is associated with alterations in HPA axis activity, and that the direction of this association depends on the timing and chronicity of the discrimination experience. There is also evidence of important modulating variables (race, socioeconomic status) and contextual confounders (emotional, situational) that warrant further study. The second study tested associations between Latino ethnicity, experiences of discrimination, and cortisol responses to an acute laboratory stressor. One hundred and fifty eight individuals (92 female, 66 male) between the ages of 18 and 29 years participated in the study. Salivary cortisol was measured before and repeatedly after the laboratory stressor, and prior discrimination experiences were measured with

the Experiences of Discrimination Scale. A moderated mediation emerged, such that Latino ethnicity predicted heightened cortisol reactivity through discrimination experiences (mediator), and this effect was further moderated by sex, with a significant indirect effect only among males. Of note, the direct path from Latino ethnicity to cortisol reactivity did not emerge as significant. Findings suggest that Latino ethnicity and discrimination interact to predict cortisol dysregulation, which implies that an appropriate model for understanding the sociocultural problem of minority health discrepancies cannot simply rely on the effects of ethnicity or discrimination alone. This research adds to the evidence that discrimination is not merely a social injustice; it is also a public health problem.

Keywords: discrimination; stigma; prejudice; stress; cortisol; HPA axis

CHAPTER 1: Introduction to the Dissertation

Introduction

Discrimination, the unequal treatment of others based on perceived differences, is a common experience for many people belonging to minority groups. Ethnicity, race, nationality, skin color, religion, sex/gender, disability status, age, and religion are common motives for discrimination. Discrimination is not just a social issue, it is a public health problem. It has been associated with a variety of negative health outcomes (Williams & Mohammed, 2009; Williams, Neighbors, & Jackson, 2008), including pre-term birth (Rosenberg, Palmer, Wise, Horton, & Corwin, 2002), psychiatric symptoms (Mays & Cochran, 2001), and hypertension (Din-Dzietham, Nembhard, Collins, & Davis, 2004). A meta-analysis found that perceived discrimination was related to poorer physical health, and this relationship operated through multiple pathways, including maladaptive stress responses, unhealthy behaviors, and psychological maladjustment (Pascoe & Richman, 2009). This relationship between discrimination and health has been found in a variety of samples, including Latino middle-school students (Romero, Martinez, & Carvajal, 2007), Aboriginal Australians (Larson, Gillies, Howard, & Coffin, 2007), and Korean immigrants (Noh, Kaspar, & Wickrama, 2007).

Conceptualizing discrimination as a chronic or acute psychosocial stressor provides a framework for understanding its damaging effects on physical and mental health. Empirical evidence supports the idea of discrimination as a stressor. A study of migrant farmworkers in the Midwest United States reported that discrimination was a major source of stress, and that the high level of stress in this study was associated with elevated rates of depressive symptoms and anxiety (Magaña & Hovey, 2003). Adolescents from ethnic minority backgrounds are especially vulnerable to stress from discrimination. Discrimination from adults and peers predicted lower self-esteem, more depressive symptoms, more distress, more physical complaints, and lower

grade point averages in a study of 744 students from Asian, Latin American, and European backgrounds (Huynh & Fuligni, 2010).

Although a link between discrimination and health outcomes has been consistently established, the psychophysiological pathways linking the two remain poorly understood. The body's physiological response to stressful discriminatory events may explain how stress from discrimination leads to poorer health. Feeling like one is missing opportunities or being treated unfairly due to race, ethnicity, or culture can increase negative emotions and result in changes to the body's physiological stress response, activating the sympathetic nervous system (SNS) and hypothalamic-pituitary-adrenocortical (HPA) axis. The SNS system, along with the parasympathetic nervous system (PNS), make up the autonomic nervous system (ANS). During periods of acute stress, downregulation of the parasympathetic nervous system and activation of the SNS system results in the rapid release of epinephrine from the adrenal medulla which allows for mobilization of energy to deal with threats and challenges (Cannon, 1929).

The majority of the research in the area of discrimination and physiological activity has shown a connection between feelings of discrimination or racism and adverse cardiovascular outcomes. Less research has examined to role of the HPA axis. The HPA system produces glucocorticoids (e.g., cortisol) in a diurnal rhythm, but also in response to stress (Chrousos, 1998). Activation of the HPA system begins when paraventricular nuclei of the hypothalamus release corticotrophin releasing hormone (CRH), which travels to the anterior pituitary where it stimulates secretion of adrenocorticotropic hormone (ACTH; Charmandari, Tsigos, & Chrousos, 2005). ACTH travels to the adrenal cortex where it stimulates production of cortisol. After it is released into the bloodstream, cortisol travels back and binds to receptors on the pituitary, hypothalamus and higher-order brain sites (e.g., the hippocampus), establishing a negative

feedback mechanism that regulates further activity of the HPA system (Charmandari et al, 2005). Whereas the SAM system takes only a few seconds to respond to stressors, controlled laboratory studies have found that HPA system may take 35 minutes or more to reach peak cortisol levels (Kirschbaum, Wust, & Hellhammer, 1992) due to its effects on gene expression in the brain and body (de Kloet, Joëls, & Holsboer, 2005).

Cortisol can be used as an estimate of how the HPA system responds to acute and chronic stressors. There are two ways to measure cortisol activity: baseline measures and stimulated reactivity. The two most commonly used baseline measures of cortisol are the cortisol awakening response (CAR; Pruessner et al., 1997) and the diurnal profile. The CAR refers to the increase in cortisol that occurs within 30 to 45 minutes after awakening and is associated with anticipation of the upcoming day (Fries, Dettenborn, & Kirschbaum, 2009). The diurnal slope can be estimated by measuring cortisol levels throughout the day. While CAR and diurnal measures of cortisol may capture basal HPA activity, they provide only a limited picture of how physiology responds to stressful events. Another way to measure cortisol is reactivity to a particular event for a specified length of time, usually a laboratory stressor. Within the regular diurnal rhythm of the HPA axis, cortisol levels fluctuate in response to discrete stressors. Laboratory stress paradigms are designed to mimic these daily stressors to get a better understanding of the acute stress response.

Chronic stress has consistently been shown to influence basal cortisol levels and cortisol response to acute stressors. Psychosocial stress may be responsible for dysregulation of the normal CAR pattern. A metaanalysis examining 142 studies found that job stress and general life stress was associated with an increased CAR, while fatigue or exhaustion was associated with a

reduced CAR (Chida & Steptoe, 2009). Chronic stress has also been associated with a flatter diurnal trajectory, resulting in an elevated daily volume of cortisol (Miller, Chen, & Zhou, 2007).

Understanding the HPA axis in the context of discrimination is important in understanding how feelings and experiences of injustice can be detrimental to mental health. While discrimination stress and subsequent activation of the autonomic nervous system has been linked to adverse physical health outcomes (e.g., cardiovascular disease) (Pascoe & Richman, 2009), negative mental health outcomes may be associated with HPA axis dysregulation (Busse et al., under review). In their biobehavioral model, Berger & Sarnyai (2015) propose that racial discrimination activates the HPA axis, the ANS, and stress-related neurotransmitters. Increased wear and tear from chronic activation leads to physical health consequences. Additionally, areas of the brain that are particularly sensitive to the social aspects of discrimination may be vulnerable to chronic activation of the HPA axis. The prefrontal cortex (PFC), anterior cingulate cortex (ACC), and a group of structures referred to as the salience network (SN) which includes the amygdala and hypothalamus, when receiving abnormally high levels of glucocorticoids, may lead to anxiety, depression, and psychosis.

To date, there have been no comprehensive reviews of the literature synthesizing the scattered literature on discrimination and the HPA axis. Study 1 systematically reviews the evidence of the link between discrimination and the HPA axis. Twenty-seven studies from 26 articles met eligibility criteria. Most studies (n = 17) were observational, and ten used experimental designs. All studies were peer-reviewed and published between 2006 and 2016.

Following up on the deficiencies in the literature, the second study experimentally tests how cultural background (Latino vs. non-Latino) and previous experiences of discrimination are associated with HPA peak response to a standardized stress task. A mediation model is proposed,

and potential moderators are also explored. Because many of the stressors encountered on a daily basis are social and interpersonal in nature, the stress paradigm in this study was intended to mimic an ambiguous but realistic scenario that could be interpreted as unfair or rooted in prejudice depending on one's past experiences.

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CHAPTER 2:

Discrimination and the HPA Axis: Current Evidence and Future Directions

Abstract

Numerous studies suggest that discrimination is associated with poor physical and mental health outcomes. Whereas the cardiovascular system has been extensively studied as a potential pathway linking discrimination with disease, the role of the hypothalamic-pituitary-adrenal (HPA) axis remains understudied. A systematic review of research was conducted on discrimination and related constructs as predictors and correlates of HPA axis activity. Twenty seven studies (10 experimental, 17 observational) met inclusion criteria. Studies suggest that discrimination is associated with HPA axis dysregulations and that the direction of this association depends on the timing and chronicity of the discrimination experience. There is also evidence of important modulating variables (race, socioeconomic status) and contextual confounders (emotional, situational) that warrant further study. Accounting for the HPA axis in addition to the cardiovascular system will contribute to a more comprehensive understanding of the biobehavioral pathways contributing to physical and mental health inequities related to discrimination.

Keywords: discrimination; stigma; prejudice; stress; cortisol

Discrimination and the HPA Axis: Current Evidence and Future Directions

Discrimination, the unequal treatment of an individual or a group of individuals based on real or perceived differences, is still a common experience, and is often based on a person's perceived or actual race, age, sex, nationality, religion, or disability. Discrimination is associated with increased mortality and a wide range of physical and, to a greater degree, mental health outcomes including depression and anxiety (Paradies et al., 2015; Williams & Mohammed, 2009). Moreover, there is growing evidence that discrimination may contribute to explaining health disparities that cannot be accounted for by sociodemographic differences (Williams, 1999; Williams & Collins, 1995).

One variable that may, at least in part, explain the health inequalities experienced by groups that have long histories of being subjected to discrimination is the stress resulting from discrimination. In support of this hypothesis, numerous studies have found an association between perceptions of discrimination or racism and perceived stress (Landrine & Klonoff, 1996; Landrine, Klonoff, Corral, Fernandez, & Roesch, 2006; Utsey, 1999). Stress-related physiological pathways, in particular the sympathetic-adrenal-medullary system, have been implicated in the discrimination-health relationship as well. Results from a meta-analysis suggest increased cardiovascular reactivity, including changes in blood pressure, mean arterial pressure, and total peripheral resistance, to discrimination manipulations (Pascoe & Smart Richman, 2009). Overall, research implicates heightened cardiovascular activity resulting from the stress of discrimination as one pathway to negative physical health outcomes, in particular cardiovascular disease.

It has been suggested that while cardiovascular dysregulations may be the primary contributor to cardiovascular disease, a physical health outcome, the influence of the stress-

responsive hypothalamic-pituitary-adrenal (HPA) system may be more relevant in terms of mental health outcomes including, for example, depressive disorders (Berger & Sarnyai, 2015). However, few studies have tested this possibility empirically. Briefly, the hypothalamus releases corticotrophin-releasing hormone (CRH), which stimulates the pituitary gland to release adrenocorticotropic hormone (ACTH), which then triggers cortisol release from the adrenal glands. The HPA axis regulates its own activity by a negative feedback system (Tsigos & Chrousos, 2002). Underlying the system's responsiveness to stressful stimuli is a pronounced circadian rhythm. Cortisol levels are highest in the morning, with a significant cortisol increase occurring within the first 30 to 45 minutes upon waking (Pruessner et al., 1997). This cortisol awakening response (CAR) is typically determined by sampling cortisol in saliva immediately after waking with one or more additional samples over the course of the next hour. Cortisol levels then decline steadily throughout the day, reaching their nadir around midnight (Weitzman et al., 1971). To obtain a diurnal profile and compute a diurnal slope, a minimum of two samples is required, one in the morning and one at night, with many studies sampling repeatedly over the course of the day. The HPA axis is also stress-responsive, and a number of procedures are available to experimentally stimulate the HPA axis by psychological, physical or pharmacological means. In the context of this discrimination literature, only psychological stress protocols have been used. In most studies, a baseline saliva sample is collected, the stress protocol is implemented, and a number of additional samples are collected after the stressor in order to obtain a response curve.

While the dynamic diurnal and stress-related processes characteristics of the HPA axis are generally adaptive, chronic dysregulations, including flatter than normal diurnal cortisol slopes, an exaggerated or attenuated cortisol awakening response, or an exaggerated or

attenuated response to external stimuli, are maladaptive and have been associated with stress-related disease, including depression and anxiety (Chrousos & Gold, 1992; Tsigos & Chrousos, 2002).

Studies directly testing the link between discrimination and HPA axis activity are reviewed and evaluated here. Studying the effects of discrimination on biobehavioral pathways implicated in physical and mental health holds promise for improving our understanding of health disparities affecting ethnic minorities and other groups likely to be persistently exposed to discrimination. This review will hopefully stimulate future work on this topic.

Method

Eligibility Criteria

Studies needed to include a measure of discrimination as a predictor and an indicator of HPA axis activity as an outcome. Because social groups that experience discrimination are typically stigmatized, or devalued by society (Crocker & Major, 1989), studies conceptualizing stigma as a chronic stressor were also included. Experimental studies had to compare a manipulation that provoked a discrimination experience with a comparison condition, or use a stressful task combined with a measure of discrimination. Studies using group membership (e.g., race, sexual orientation) as a proxy for discrimination experiences were not included because the unique contribution of discrimination in those studies could not be isolated. For a similar reason, studies of discrimination experiences among individuals with chronic disease (e.g., diabetes) were excluded. Studies using allostatic load as an outcome variable were excluded unless associations with individual hormones were also reported. Studies focusing on related concepts such as *internalized racism* or *race-based rejection sensitivity* were deemed beyond the scope of this article. Only studies of human participants were included.

Literature Search

PsycINFO and PubMed were searched for peer-reviewed studies published in English without setting restrictions on publication date. Keywords related to the HPA system included *cortisol, CRH, corticotropin releasing hormone, ACTH, adrenocorticotropin releasing hormone, beta-endorphin, Dehydroepiandrosterone,* and *DHEA*. These words were matched with the discrimination-related keywords: *discrimination [major headings: Pubmed: majr; PsycInfo: mjsub], prejudice [major headings], racis*, stigma, sexis*, unfair treatment, ageis*, homophob* and xenophob**. The final search was run in October of 2016.

Identification and Selection of Literature

The search located 138 entries through PubMed and 29 entries through PsycINFO, with 24 duplicate entries (see Figure 1). To locate additional articles the database search might have missed, review articles and relevant empirical articles were searched for additional references. Seven studies were found using this method. Thus, 150 manuscripts were further considered. A review of titles and abstracts resulted in the rejection of 97 articles that were either not empirical studies or clearly irrelevant. The remaining 53 full-text articles were further examined and 27 were excluded for various reasons (see Figure 1). The remaining 26 articles describing 27 studies met eligibility criteria and were included in this review.

These 27 studies reported on a total of 4,328 participants, with sample sizes ranging from 33 participants in a unique study surrounding the 2006 Duke lacrosse scandal (Richman & Jonassaint, 2008) to 781 participants constituting a subsample of a large multisite study on race and socioeconomic status (Cohen et al., 2006). The mean study sample size was 160.3 (SD = 178.3). Ten studies included only female participants. In the 16 studies reporting gender breakdown, females comprised 58.4% of the combined study samples. In the 18 studies that

reported age, participants' ages ranged from a low of 9 years (Martin, Bruce, & Fisher, 2012) to a high of 98 years old (Hehman & Bugental, 2015), with a mean age of 27.0 (SD=13.4) across studies. Twenty two studies collected their samples in the United States, and the remaining studies in Canada (n = 3), New Zealand (n = 1), and China (n = 1). Across all studies reporting race or ethnicity, most participants identified as White (31.2%), Black (27.0%) or Asian (23.9), and the remaining participants as Latino (14.5%) or other (3.4%).

Results

Ten studies used an experimental design, and 17 studies were observational with two longitudinal and 15 cross-sectional studies.

Experimental Studies

The ten experimental studies varied in size between 33 and 110 participants (Table 1). All provided evidence of an association between discrimination or closely related concepts (e.g., structural stigma) and salivary cortisol reactivity, using a range of moderately stressful tasks, including experimentally induced discrimination experiences (Hehman & Bugental, 2015; Himmelstein, Incollingo Belsky, & Tomiyama, 2015; Jamieson, Koslov, Nock, & Mendes, 2013; Matheson & Anisman, 2009; Matheson, Gill, Kelly, & Anisman, 2008), speech tasks (Hatzenbuehler & McLaughlin, 2014; Richman & Jonassaint, 2008), and prejudiced work paradigms (Townsend, Eliezer, Major, & Mendes, 2014; Townsend, Major, Gangi, & Mendes, 2011). Discrimination experiences in these studies were based on participants' race (Jamieson et al., 2013; Richman & Jonassaint, 2008; Townsend et al., 2014), age (Hehman & Bugental, 2015), sex (Townsend et al., 2014; Townsend et al., 2011), sexual orientation (Hatzenbuehler & McLaughlin, 2014), and body weight (Himmelstein et al., 2015). In all studies, at least two saliva

samples were collected, one sample before the experimental manipulation and at least one sample after the task, reflecting reactivity and recovery.

Heightened reactivity with discrimination. Four studies found more pronounced cortisol responses to an experimentally induced sex, age or race discrimination experience compared to a control condition. The most recent of these is a study of 108 younger and older adults who were given instructions for a task using either patronizing or non-patronizing speech. Older adults showed a marginal cortisol increase in response to the ageist treatment, whereas younger adults, and participants in the non-patronizing condition did not (Hehman & Bugental, 2015). An interactive effect was also observed in a sample of 58 working and middle class US Latinas who participated in a mock job interview with a racially prejudiced or unprejudiced interviewer (Townsend et al., 2014). Middle class Latinas in the prejudiced condition showed higher cortisol responses and lower anabolic balance than those in the unprejudiced condition. Working-class Latinas, however, did not show this pattern suggesting that SES may be an important moderator in the link between discrimination and cortisol reactivity.

The same group of authors, in a set of two studies, investigated how chronic perceptions of sexism can influence cortisol responses to situations in which sexist interactions occur or may occur (Townsend et al., 2011). In study 1, female participants acting as applicants in a mock job interview received either sexist or merit-based negative feedback about their performance. In the sexist but not in the merit condition, women who scored high on chronic perceptions of sexism had higher cortisol levels 20 and 30 minutes after the interview compared to low-scoring women. In study 2, female participants interacted with a male confederate with either sexist or unknown attitudes. Regardless of condition, the female participants with higher chronic perceptions of sexism had higher cortisol levels 20 and 30 minutes after the interview, suggesting that chronic

perceptions of sexism may predispose women to greater cortisol reactivity not only during sexist interactions but also during interactions where sexism is not overtly present, but also not precluded. In a fifth study, an overall cortisol increase to weight stigma exposure was not observed. However, in line with the pattern of increased responses in the four studies reported above, women who perceived their weight as heavy maintained higher cortisol levels after a procedure designed to induce weight stigma, whereas women who perceived their weight as normal showed cortisol decreases (Himmelstein et al., 2015).

Reduced reactivity with discrimination. In contrast, three studies reported blunted cortisol responses with discrimination (Hatzenbuehler & McLaughlin, 2014; Jamieson et al., 2013; Richman & Jonassaint, 2008). During data collection for a study on the role of racial identity in moderating social-evaluative threats, members of the Duke University lacrosse team were accused of sexual assault by an African American woman. This incident, which received extensive national publicity and exposed racial and class divides in the university community, created significant stress for African American students and African American women on campus in particular (Richman & Jonassaint, 2008). Participants in the study, all of whom were African American, who completed the speech task before this naturally occurring stressor showed a typical stress response with peak cortisol responses occurring 20-minutes post stressor. In contrast, participants who completed the stress task after the scandal had higher baseline cortisol levels and a flatter cortisol trajectory. This effect was particularly strong among women. In another study, Hatzenbuehler and McLaughlin (2014) found that Lesbian, Gay, and Bisexual (LGB) young adults who were raised in environments high in structural stigma showed blunted responses to a laboratory stressor compared to LGB youth raised in environments low in structural stigma. Finally, being rejected during a speech task by someone of a different race,

which participants could interpret as an act of discrimination, resulted in more blunted cortisol responses to rejection than being rejected by someone of the same race (Jamieson et al., 2013).

Studies testing modulating variables. The final two studies used mood prime techniques to assess the role of emotions and coping on cortisol responses to an acute sex-discrimination protocol. In the first of these studies (Matheson et al., 2008), an overall cortisol response was not observed. However, among women who had been primed to feel sad, cortisol continued to decrease until 30 minutes after the discrimination protocol, while cortisol remained elevated in the anger-primed participants. In the second study, Matheson and Anisman (2009) found that among participants primed to feel anger, greater problem-focused coping was associated with cortisol decreases following a simulated discrimination experience. The combination of no mood prime and avoidant coping style was associated with higher levels of cortisol.

Observational Studies

Among the 17 observational studies (Table 1), two used prospective designs whereas all others were cross-sectional. Most studies collected a baseline sample shortly after waking up and additional samples throughout the day for several days to obtain a diurnal cortisol profile. One study collected a single saliva sample in the afternoon, which was assessed for cortisol and DHEA (Ratner, Halim, & Amodio, 2013), one study assessed urinary cortisol (Brody et al., 2014) and one study collected a single blood sample for assessment of placental CRH in pregnant women (Tse, Rich-Edwards, Koenen, & Wright, 2012).

Diurnal slope. The first and largest set of observational studies tested the link between the diurnal cortisol slope and discrimination, hypothesizing that flatter cortisol slopes with lower morning and higher evening cortisol levels are maladaptive and associated with experiences of

discrimination. Most studies reported results in support of this hypothesis. Adam et al. (2015) recruited 50 Black and 62 White individuals when they were 12 years old and followed them across a 20-year period. Perceived discrimination averaged over two decades predicted flatter diurnal cortisol in both Black and White adults, with a more pronounced effect among Blacks. Moreover, the effect was stronger when perceived discrimination was experienced in adolescence than when it was experienced in young adulthood, indicating that chronicity of the discrimination exposure may be of importance. Several cross sectional studies confirm this finding. Skinner, Shirtcliff, Haggerty, Coe, and Catalano (2011), in a study of 275 young Black and White adults, found higher perceived lifetime experiences of discrimination with flatter cortisol slopes, regardless of race. Similarly, a study of LGB young adults linked stressful life events related to LGB identity occurring over the past three months with flatter cortisol slopes, which in turn predicted depressive symptoms (Parra, Benibgui, Helm, & Hastings, 2016). Moreover, a link between higher perceived stigma and flatter diurnal cortisol slopes as well as lower morning cortisol levels was found in a study of 645 children from rural China living in families with at least one HIV positive parent (Chi et al., 2015).

Two studies provide further evidence for flatter cortisol slopes with everyday experiences of discrimination and also report some indication of racial differences. Zeiders, Hoyt, and Adam (2014), in a study of 140 upper-middle class adolescents, found flatter diurnal cortisol slopes with perceived discrimination among ethnic minority adolescents, but not among European Americans. Similarly, Huynh, Guan, Almeida, McCreath, and Fuligni (2016), in a study of 293 high school students scoring low on everyday discrimination, found flatter cortisol slopes and lower morning cortisol levels in teenagers of European background but not among Latino adolescents. Two studies reported null findings for diurnal cortisol slopes, but found experiences

of discrimination associated with higher evening cortisol in 179 preadolescents (Martin et al., 2012) and 55 women late in pregnancy (Thayer & Kuzawa, 2015), providing at least some support for diurnal changes in cortisol secretion in the hypothesized direction. Of interest, Thayer and Kuzawa (2015) further observed more pronounced cortisol responses in the six-week old offspring of women experiencing discrimination, suggesting a possible transgenerational pathway to health disparities.

Not all studies consistently link discrimination with flatter cortisol slopes, however. Another group of studies, some with large sample sizes, report null findings for the link between discrimination and the cortisol diurnal slope (Cohen et al., 2006; Doane & Zeiders, 2014) or individual cortisol samples in the morning or evening (Cohen et al., 2006; Doane & Zeiders, 2014; Ratner et al., 2013; Zeiders, Doane, & Roosa, 2012). A single study of 41 Black and Latina women found no association between afternoon DHEA and perceived racial discrimination (Ratner et al., 2013).

Two studies provide evidence for an association in the opposite direction. In older African American adults and a matched sample of European Americans, African Americans reporting higher levels of perceived, predominantly racial, discrimination showed a steeper cortisol decline over the course of the day compared to African Americans reporting lower levels of discrimination. Moreover, among low SES African Americans, those who reported low levels of discrimination had the flattest, or least healthy, diurnal cortisol slopes (Fuller-Rowell, Doan, & Eccles, 2012). Higher weight stigma experiences were also associated with higher morning serum cortisol among 47 women from the US, although no associations were found between weight stigma and the diurnal slope (Tomiyama et al., 2014).

Overall diurnal cortisol secretion. Two studies, both discussed above, found significantly more overall diurnal cortisol secretion in participants scoring high on perceived discrimination (Huynh et al., 2016; Zeiders et al., 2012). In contrast, a study of 146 adult Native Hawaiians found lower average cortisol levels among those with higher perceived racism (Kaholokula et al., 2012). Two studies point toward the absence of an association (Cohen et al., 2006; Tomiyama et al., 2014), a finding in line with the only longitudinal study testing this association; Brody et al. (2014) followed 331 Black 16-year olds for four years and found no associations between perceived discrimination and overnight 12-hour urine cortisol.

The cortisol awakening response. Adam et al. (2015) found that averaged perceived discrimination over the past two decades predicted a lower cortisol awakening response in both Black and White adults, with a more pronounced effect among Blacks and when discrimination was experienced in adolescence. Three other studies found a link between discrimination experiences and a more pronounced cortisol awakening response. Zeiders et al. (2012) report a trend toward a steeper cortisol awakening response with higher perceived discrimination. In a separate sample of 77 adolescents, these authors replicate their previous finding, and provide further evidence of more pronounced cortisol responses to negative affects among those experiencing more discrimination (Doane & Zeiders, 2014). Similarly, weight stigma frequency was associated with a more pronounced cortisol awakening response in one study (Tomiyama et al., 2014). Two large studies of 781 Black and White young adults (Cohen et al., 2006) and 645 Chinese youth from families affected by HIV reported no significant association between the morning cortisol increase and measures of discrimination and stigma, respectively.

CRH and discrimination. A single study tested the link between perceived racial discrimination and CRH levels in a predominantly Hispanic and Black sample of pregnant

women (Tse et al., 2012). Although no associations were found in the full sample, analyses stratified by race showed a U-shaped association among Black women. Women reporting either no discrimination experiences or three or more types of discrimination had higher CRH levels than women with one or two types of discrimination experiences.

Discussion

The literature on HPA axis activity and experiences of discrimination were reviewed and evaluated. Twenty-seven studies, ten experimental and 17 observational, were identified. For the most part, studies investigated the link between cortisol and discrimination. Two studies measured DHEA and one studied placental CRH. At first glance, findings appear inconsistent. Among the experimental studies, some provide evidence for more pronounced cortisol responses to acute laboratory stress while others point to blunted responses with discrimination. Similarly, among the observational studies, some associate discrimination with steeper diurnal slopes, higher morning and lower evening cortisol, lower overall diurnal output and a more pronounced cortisol awakening response, but at least as many studies yielded null findings or findings in the opposite direction. However, the majority of discrepant findings can be reconciled by considering the timing and chronicity of the discrimination experience, modulating variables such as race and SES, as well as emotional and situational contextual confounders.

In terms of the timing and chronicity of the discrimination experience, findings differed depending on whether studies conceptualized and measured discrimination as a chronic or life-time stressor versus an acute or fairly recent event. Looking at the experimental studies first, two types of studies could be identified. The first type of studies compared individuals' responses to laboratory stressors that either did or did not include an element of discrimination, thereby conceptualizing discrimination as an acute event. These studies showed more pronounced

cortisol responses with discrimination experiences (Hehman & Bugental, 2015; Townsend et al., 2014; Townsend et al., 2011), and in one case ongoing elevation of cortisol levels in the absence of a cortisol response (Himmelstein et al., 2015). These findings integrate well with a neurobiological model of racial discrimination and health, which posits that ongoing experiences of discrimination result in HPA system dysregulations, which in turn lead to structural and functional changes in brain networks associated with heightened reactivity to acute stressors, and ultimately contribute to an increased risk of adverse mental health outcomes (Berger & Sarnyai, 2015). Conversely, the second set of studies compared how individuals with and without prior experiences of discrimination respond to a non-discriminatory laboratory stressor, thus conceptualizing discrimination as chronic. In those studies, a history of discrimination was associated with more blunted cortisol responses (Hatzenbuehler & McLaughlin, 2014; Jamieson et al., 2013; Richman & Jonassaint, 2008). Overall, it appears that individuals exposed to discrimination show overall blunted responses to stress, unless the stressor includes an element of discrimination, in which case heightened stress reactivity may occur.

In terms of the chronicity of experience, a similar pattern of findings emerged for the observational studies. The two studies assessing racial discrimination experiences over at least two decades provide evidence of flatter diurnal cortisol slopes (Adam et al., 2015; Skinner et al., 2011) and a lower cortisol awakening response (Adam et al., 2015). While conclusions based on two studies are necessarily preliminary, these findings align closely with those of an influential meta-analytic review of chronic stress and HPA axis function (Miller, Chen, & Zhou, 2007). Across 119 studies, individuals with high exposure to chronic stress exhibited a dysregulated cortisol pattern characterized by a flatter diurnal cortisol slope, lower morning and higher evening cortisol levels, as well as higher cortisol output throughout the day. Differential health-

related outcomes depending on the chronicity of the discrimination experience have also been documented in a nationally representative sample in which major depression in the past year was associated with everyday discrimination but not with past major events of discrimination (Hudson et al., 2012).

The remaining observational studies considered discrimination experiences that occurred over various periods of time but within a maximum of one year, and findings are more conflicting. Some studies are in line with a chronic stress pattern, linking discrimination with flatter diurnal slopes (Chi et al., 2015; Parra et al., 2016), flatter diurnal slopes in subgroups of individuals (Huynh et al., 2016; Zeiders et al., 2014), and higher evening cortisol levels in the absence of differences in diurnal slopes (Martin et al., 2012; Thayer & Kuzawa, 2015). Conversely, other studies yielded patterns more consistent with cortisol dysregulations expected with acute stress (Miller et al., 2007), and report on steeper cortisol diurnal slopes (Fuller-Rowell et al., 2012), higher morning cortisol levels in the absence of altered diurnal slopes (Tomiyama et al., 2014), and a more pronounced cortisol awakening response (Doane & Zeiders, 2014; Tomiyama et al., 2014; Zeiders et al., 2012) with discrimination. Yet another set of studies did not detect significant associations between discrimination experiences and the diurnal slope (Cohen et al., 2006; Doane & Zeiders, 2014), cortisol levels in the morning or evening (Cohen et al., 2006; Doane & Zeiders, 2014; Ratner et al., 2013; Zeiders et al., 2012), overall secretion throughout the day (Brody et al., 2014), or the cortisol awakening response (Chi et al., 2015; Cohen et al., 2006). Even though individuals in these studies were asked to consider only discrimination experiences in the past year, it may be that their discrimination experiences in the past year are reflective of a life-long pattern, and thus the observed cortisol dysregulations map on to a chronic stress pattern. Other studies may have truly captured recent events, favoring the

detection of cortisol changes indicative of acute stress. Of note, the only observational study measuring truly acute stress by assessing cortisol changes in response to negative affect using Ecological Momentary Assessment methods yielded findings in line with predictions for an acute stress model (Doane & Zeiders, 2014). It may, of course, also be the case that the somewhat inconsistent findings within the observational studies indicate that the neurobiological changes associated with ongoing discrimination may just be less apparent in the baseline functioning of the HPA system, and instead be more salient in the context of an acute discrimination stressor occurring (Berger & Sarnyai, 2015).

This review further provides evidence that race and SES may modulate the association between discrimination and HPA axis activity. Studies typically included racially diverse samples, and some of these tested the effects of race as a modulating variable. From these studies, it appears that discrimination can be associated with HPA axis dysregulation, regardless of race (e.g., Skinner et al., 2011) and that racial differences in HPA axis activity cannot be solely explained by discrimination experiences (e.g., Martin et al., 2012). Some studies provided evidence that discrimination and race interact to predict cortisol dysregulations. For example, associations between self-reported discrimination and HPA axis dysregulations were found in ethnic minority individuals but not in European Americans (Zeiders et al., 2014), in European Americans but not in Latinos (Huynh et al., 2016), and in African American but not in Latina pregnant women (Tse et al., 2012). There is ample evidence that strong family networks and social support may act as a buffer in the link between stress, stress-related biological processes and negative health outcomes (Cohen, 2004; Uchino, 2006; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Latinos tend to be higher in familism, a construct that describes a sense of interconnectedness, support, and obligation towards family (Sabogal, Marín, Otero-Sabogal, &

Marín, 1987). Thus, familism may be a more proximal predictor of HPA axis regulation than race, which could explain why some studies did not detect links between discrimination and cortisol dysregulation among Latinos. Alternatively, it is possible that discrimination itself is a mediator in the link between race or SES and HPA axis dysregulation. While a study testing this hypothesis directly could not be identified, there is certainly a need to address this question in future empirical work. Of course, another possibility is that low statistical power in some studies or the use of measures capturing discrimination adequately in one race but not the other, contributed to some of these negative findings.

In terms of SES, one study observed the flattest diurnal cortisol slopes among African Americans who reported a low level of discrimination and were also low SES (Fuller-Rowell et al., 2012). Similarly, cortisol dysregulations with discrimination were found among middle class but not working-class Latina American women (Townsend et al., 2014). Of note, higher SES in these studies was not protective, a finding aligned with reports of higher major depression rates in high SES compared to low SES African American men exposed to discrimination (Hudson et al., 2012). The authors of that study theorize that the salience of higher structural barriers and larger racial differences in financial compensation among highly educated African American men may explain these findings. Based on this limited evidence, SES appears to be a relevant moderator, although it should be pointed out that the link between discrimination and HPA axis regulation remained significant after controlling for income or education in a number of studies (Doane & Zeiders, 2014; Kaholokula et al., 2012; Skinner et al., 2011; Tomiyama et al., 2014; Tse et al., 2012).

A small set of studies tested whether social contextual variables can influence how individuals respond to discrimination. One study points to the importance of the race of the

perpetrator of discrimination. Jamieson et al. (2013) found that cortisol responses to a laboratory stressor were blunted in individuals rejected by a member of a different race compared to individuals experiencing same-race rejection. Two other studies, published in a single manuscript, tested how interactions between dispositional attitudes and cues from an authority figure influence individuals' responses to potential discrimination. Findings suggest that chronic perceptions of sexism may predispose women to greater cortisol reactivity during sexist interactions and in interactions where sexism is not present but also not precluded (Townsend et al., 2011). Together, these studies suggest that detrimental effects of discrimination on HPA axis regulation may also depend on socio-contextual variables.

A final set of studies provide evidence for the importance of emotions and preferred coping strategies in the link between discrimination and HPA axis dysregulation. One study showed that youth reporting high levels of discrimination showed more pronounced momentary cortisol increases to negative affect compared to youths experiencing lower levels of discrimination (Doane & Zeiders, 2014). Another study showed that an anger prime but not a sadness prime prolonged cortisol responses to an acute discrimination experience (Matheson et al., 2008). The same authors showed that among those primed with anger, problem-focused and avoidant coping styles were associated with decreasing cortisol following a simulated discrimination experience, whereas among those primed with shame an avoidant style was associated with reduced cortisol reactivity (Matheson & Anisman, 2009). A final study provided trend-level evidence pointing to emotional support as a buffer in the link between discrimination and cortisol dysregulation (Brody et al., 2014). In sum, it appears that individuals' emotions and coping styles are relevant factors to consider in terms of HPA axis dysregulation following discrimination experiences.

In sum, this review of the literature suggests that experiences of discrimination are associated with dysregulation of the HPA axis. Thus, accounting for the HPA axis in addition to the more frequently studied cardiovascular system is important in terms of developing a better understanding of the complex biobehavioral pathways that contribute to discrimination-related physical and mental health inequities. The literature reviewed here provides evidence that the timing and duration of discrimination experiences are central to understanding how experiences of discrimination may lead to dysregulations in the HPA system, and ultimately result in stress-related disease. Finally, it appears that important modulators including race and SES as well as emotional and social contextual factors play an important role in this line of research.

Moving forward, it is recommended that studies move away from simple correlational designs in favor of experimental designs and prospective approaches. Because experiencing multiple forms of discrimination has been associated with worse mental and physical health than experiencing only one form of discrimination (Grollman, 2012), a more comprehensive assessment of multiple forms of discrimination and their relative impact is suggested. Similarly, studies should address the complexity of the physiological consequences of discrimination by carefully addressing interactive processes between stress-related systems, including for example the HPA axis and the cardiovascular system. Finally, there is a need for further research on relevant modulators in the link between discrimination and HPA axis dysregulations, including variables that could be sources of resilience for groups chronically exposed to discrimination. This latter direction has the potential to shed light on inequalities in minority health and may point toward promising approaches for achieving health equality. In sum, it is recommend that future studies take a theory-driven, prospective approach to testing the biobehavioral mechanisms leading from discrimination experiences to negative physical and mental health outcomes.

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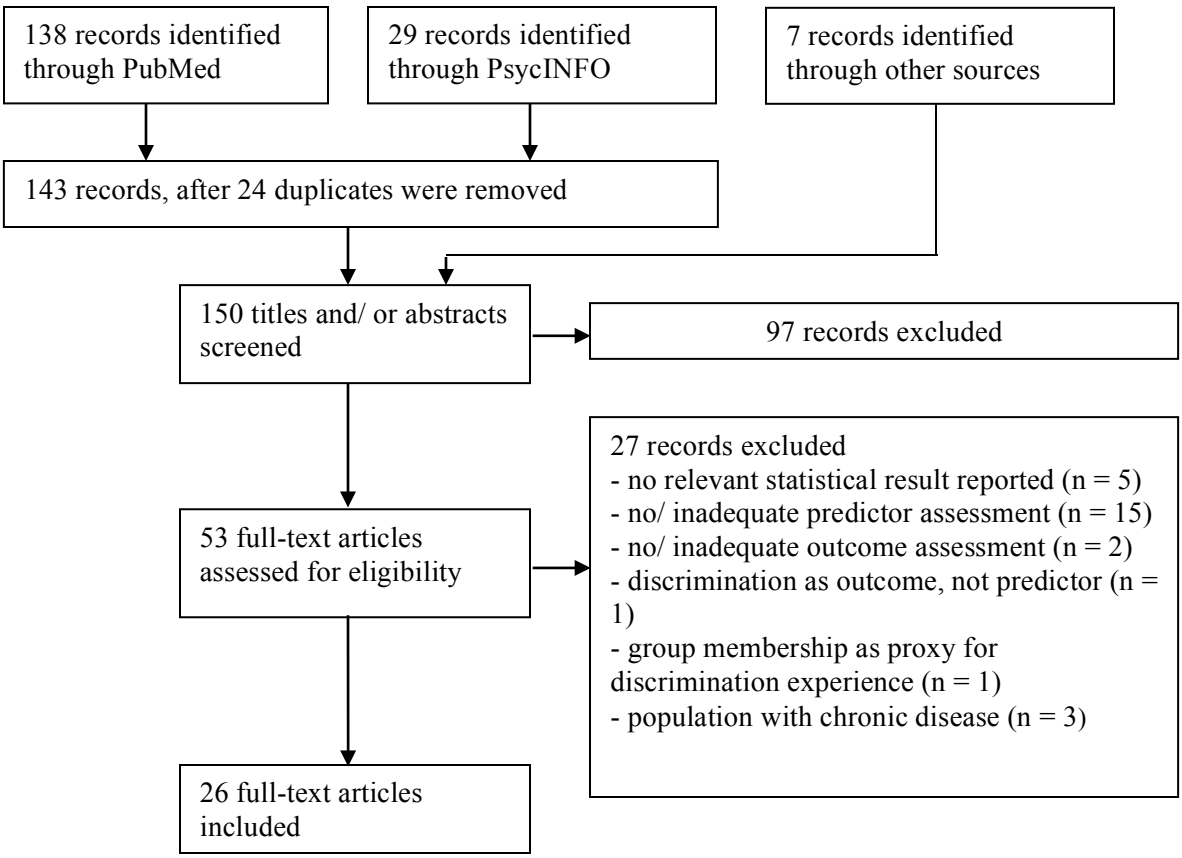

Figure 1. Flow chart following guidelines in the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009).

Table 1
Studies of Discrimination and the HPA Axis

Study	Exclusion criteria[a]	Sample	Discrimination measure and/or experimental manipulation	HPA axis measure	Major findings and control variables (in italics)
EXPERIMENTAL STUDIES					
Hatzenbuehler & McLaughlin, 2014		74 LGB adults, M_{age} = 24 yrs, 54% female, 60% non-White, 40% White, from colleges and community in large US metropolitan city	Stressor: TSST Structural Stigma[b], Perceived Devaluation-Discrimination Scale	sCORT: 3 samples (baseline, reactivity, recovery)	LGB youth w/ prior structural stigma had blunted sCORT response. *Age, sex, race, wake time, smoking, exercise, caffeine.*
Hehman et al., 2015		108 US adults, 47 younger adults: 49% female, 18 – 24 yrs, M_{age} = 19; 64% White, 15% Hispanic, 9% Asian, 6% Black, 6% other), 61 older adults: (72% female, 61 – 98 yrs, M_{age} = 75; 82% White, 12% Hispanic, 3% Black, 2% Asian, 2% other)	Delivering instructions for puzzle task using patronizing vs non-patronizing speech	sCORT: 2 samples (baseline, +20 min)	Marginal sCORT increase only in older adults in patronizing condition. Positive attitudes about aging and positive interactions with younger generation protective.
Himmelstein et al., 2015	Self-perception of being thin, smoking	110 US female undergraduate students, 17-57 yrs, M_{age}=20 yrs, 28% Asian, 21% Hispanic, 15% White, 5% Black, 2% Middle Eastern, 1% Native American, 18% multi-racial, 10% other	Virtual shopping trip w/ and w/o prior induction of weight stigma	sCORT: 2 samples (baseline, +30 min)	Women perceiving weight as heavy in stigma condition w/ higher sCORT after test than control group or women perceiving weight as average. No effect of BMI. *BMI, negative affect*

Jamieson et al., 2013	Hypertension, pacemaker, cardiac meds, pregnant	91 US adults from student and community samples, M_{age} = 24 yrs, 55% female, 54% White, 46% Black, from Cambridge, MA	Stressor: Computerized social rejection task In-group vs. outgroup rejection	sCORT: 3 samples (baseline, reactivity, recovery)	Same-race rejection w/ greater sCORT reactivity than cross-race rejection.
Matheson & Anisman, 2009	Immune illness, meds affecting cortisol	91 first-year female university students, M_{age} = 20 yrs, 72% White, 14% Asian, 7% Black, 1% Hispanic, 6% other, from Canada.	Mood prime (anger vs shame vs no prime control) followed by sex discrimination protocol	sCORT: baseline, +20 min following mood prime; +15 min and +30 min following failure feedback	Anger prime plus problem-focused or avoidant coping w/ decreasing sCORT. Shame prime plus avoidant coping w/ reduced reactivity. No prime plus avoidant coping w/ greater reactivity.
Matheson et al., 2008	Neuroleptics, drugs affecting cortisol	61 first-year female university students, M_{age} = 21 yrs, 80% White, 12% Asian, 7% Black, 1% other, from Canada	Mood prime (anger vs sadness) followed by sex discrimination protocol	sCORT: Baseline, +15 min, +30 min	Discrimination after anger prime w/ elevated sCORT. Sad prime w/ decreased sCORT. *Time of day, med use.*
Richman & Jonassaint, 2008	Anti-depressant or anti-anxiety meds, anabolic steroids, nasal sprays, mouth lacerations, some medical conditions.	33 Black university students, 52 % female, from North Carolina (USA). 52% recruited pre-Duke Lacrosse scandal.	Stressor: Speech task Two conditions designed to increase either school or racial identity	sCORT: Baseline, +20 min, +30 min, +40 min	Post Duke Lacrosse w/ elevated sCORT levels and blunted responses; stronger in women. *Racial identity, OC use, time of day, major stress.*

Townsend et al., 2013	58 working and middle class US Latina women	Interview prejudice paradigm w/ racist vs not racist interviewer	sCORT, DHEA: baseline, 3 samples after negative feedback	Middle-class Latinas in prejudiced condition w/ higher sCORT, lower anabolic balance.
Townsend et al., 2011	Study 1: 61 White female US college students Study 2: 52 White female US college students	Study 1: Job interview paradigm w/ merit or sexist rejection feedback Study 2: Coworker paradigm w/ prejudiced or unprejudiced attitudes	sCORT: Study 1: Baseline, +20 min, +30 min, +40 min post-stressor Study 2: Baseline, +25 min, +35 min, post-stressor	Study 1: Chronic perceived sexism and identity-threatening cues w/ higher sCORT reactivity than identity-safe cues Study 2: Chronic perceived sexism w/ higher sCORT reactivity regardless of condition. *Baseline sCORT, wake time, menstrual cycle, age, anxiety, depression, perceived personal control.*
OBSERVATIONAL STUDIES				
Adam et al., 2015	112 US adults from the Maryland Adolescent Development in Context Study, assessed at ages 12 and 32, 61% female, 55% White, 45% Black	Perceived racial discrimination; modified daily life experiences scale of racism and life experiences scale.	sCORT: 3 samples per day for 1 wk (awakening, +30 min, bedtime)	Blacks w/ lower waking sCORT than Whites. Waking sCORT decreased as cumulative perceived racial discrimination increased for Blacks. *Depressive symptoms.*

Brody et al., 2014		331 US Black adults from rural Georgia, assessed repeatedly from 16 to 20 yrs, 66% female	Schedule of Racist Events at age 16-18	Allostatic load: BP, urinary cortisol, epinephrine, norepinephrine, C-reactive protein	High perceived discrimination w/ high allostatic load. Trend for urinary cortisol. Emotional support buffered effects.
Chi et al., 2015	HIV infection (child)	645 children from villages in central China, 8-15 yrs (M_{age}: 10), 48% female, low SES, parent w/ HIV infection.	Stigma Against Children Affected by AIDS Scale	sCORT (awakening, +30 min, 1 hr before dinner, bedtime)	High perceived stigma w/ lower awakening cortisol and flatter diurnal slope. CAR n.s. *Age, sex, SES, wake time, sleep quality, stressful life events, parental death, perceived health, weekend vs. weekday assessment.*
Cohen et al., 2006	Blind, deaf, mute, "mentally retarded", unable to walk on treadmill, pregnant	781 US White and Black adults, recruited at ages 18-24 and 25-30, from Chicago, Illinois and Oakland, CA	Self-reported frequency of discrimination	sCORT: 6 samples for 1 day (awakening, +45 min, +2.5 hrs, +8 hrs, +12 hrs, bedtime)	Blacks w/ higher evening sCORT than Whites. sCORT and discrimination n.s. *Sex, age, BMI, wake time.*
Doane & Zeiders, 2014		77 adolescents from southwestern US, M_{age} = 18 yrs, 77% female, 55% White, 23% Hispanic, 5% Asian, 5% Black, 12% multi-racial	10 item Everyday Discrimination Scale based	sCORT: 6 samples for 1 day (awakening, +45 min, +2.5 hrs, +8 hrs, +12 hrs, bedtime); EMA diary entries coordinated w/ saliva samples	High discrimination w/ increased sCORT responses to negative affect. *Negative affect; wake time, sex, race, parent education, OC use.*

Fuller-Rowell et al., 2012		150 US adults, M_{age} = 57 yrs, 58% female, 67% White, 33% Black	The Prevalences of Lifetime and Day-To- Day Perceived Discrimination	sCORT: 4 samples/day for 4 days (awakening, +30 min, before lunch, bedtime)	Perceived discrimination w/ steeper diurnal slope in Blacks. Low SES Blacks w/ low discrimination had flattest slopes.
Huynh et al., 2016		292 US adolescents, M_{age} = 16 yrs, 58% female, 42% Latin American, 29% White, 23% Asian American, 6% other, from public high schools in Los Angeles, CA	10 item Everyday Discrimination Scale	sCORT: 5 samples/day for 3 days (awakening, +15 min, +30 min, before dinner, bedtime)	More discrimination w/ greater total daily sCORT, lower waking sCORT, greater bedtime sCORT, and flatter daily decline. *Wake time, ethnicity, gender, age, BMI.*
Kaholokula et al., 2012	Pregnant, <18 yrs	146 adult native Hawaiians (USA), M_{age} = 55 yrs, 71% female	10-item Oppression Questionnaire	sCORT: 2 samples, one A.M. and one P.M.	More attributed racism[c] w/ lower diurnal sCORT. *Perceived stress, cultural identity, BP, BMI, mainstream and ethnic identification, age, sex, education, marital status, Hawaiian ancestry.*
Martin et al., 2012	Steroids	179 preadolescents, 9-12 yrs, M_{age} = 11 yrs, 53% female, 50% Hispanic/Latino, 15% Black, 15% White, 4% Asian, 16% multiracial, from San Diego, CA	12-item perceived discrimination questionnaire	sCORT: 3 samples/day for 3 days (morning, afternoon, bedtime)	Discrimination w/ sCORT n.s.

Parra et al., 2016	Steroids	62 LGB young adults, 17-27 yrs (M_{age} = 21 yrs), 43% female, 79% White from Montreal, QC	12-item Revised Gay-Related Stressful Life Events Measure	sCORT: 6 samples for 1 day (awakening, +2, +4, +6, +8 and +12 hrs)	More LGB-related stress w/ flatter diurnal slopes, which resulted in more depression.
Ratner et al., 2013	Pregnant, OC, breastfeeding, menopause	41 US women, M_{age} = 29 yrs, 66% Black, 27% Latina, 7% Black-Latina, from New York, NY	9-item Williams Everyday Discrimination Scale	sCORT: 1 P.M. sample. Salivary DHEA	Discrimination w/ cortisol, DHEA n.s.
Skinner et al., 2011		275 US adults, M_{age} = 20 yrs, about half female, 54% White; 46% Black from Seattle, WA	10 items from Harrell Discrimination Scale	sCORT: 4 samples/day for 3 days (awakening, +30 min, after lunch, bedtime)	Higher discrimination w/ flatter diurnal slope. Blacks w/ flatter slopes than Whites. *Gender, family income in adolescence, sleep.*
Thayer & Kuzawa, 2015		55 pregnant women, M_{age} = 31 yrs, 34 to 36 wks' gestational age, 53% White, 27% Maori, 20% Asian, from New Zealand	Modified Williams Everyday Discrimination Scale	sCORT: 2 samples/day for 2 days. Infant saliva samples before and 25 min after vaccination	Ethnic discrimination w/ higher pregnancy evening sCORT and greater response to vaccination in 6-wk old infants. *Time, age, BMI, ethnicity, meds.*

Tomiyama et al., 2014	BMI < 25 or > 40, menopausal, some disease states, pregnancy, relaxation techniques, substance use	47 US women from San Francisco, CA, M_{age} = 41 yrs, 62% White, 19% Asian/Pacific Islander, 15% Hispanic/Latino, 4% Other	50-item stigmatizing situations inventory; 10-item stigma consciousness scale	sCORT: 3 samples/day for 4 days (awakening, +30 min, bedtime)	Weight stigma consciousness and frequency positively associated w/ morning serum cortisol and CAR. *Adiposity, oxidative stress*, *income, education, global perceived stress.*
Tse et al., 2012	Non-singleton pregnancy, steroid use, shift work	176 US pregnant women ≥18 yrs, 63% Hispanic, 26% Black, 11% White, from Boston, MA	Self-reported frequency of discrimination	pCRH, once between 20 and 37 wks' gestational age (mean 28.1 wks)	Discrimination w/ higher pCRH in Blacks. *Parity, race, education, BMI, nativity.*
Zeiders et al., 2012	Corticosteroids	100 Mexican-American adolescents, M_{age} = 15 yrs, 51% female, 86% US-born	Brief Perceived Ethnic Discrimination Questionnaire	sCORT: 3 samples/day for 3 days (awakening, +30 min, bedtime)	Perceived discrimination w/ greater overall sCORT and steeper CAR.
Zeiders et al., 2014	Corticosteroids	140 young, upper-middle class US adults, 73% female, 54% White, 14% Latino, 8% Black, 6% Asian, 11% Multi-ethnic, 7% Other	Williams Everyday Discrimination Scale	sCORT: 6 samples/day for 3 consecutive weekdays	Diurnal sCORT and discrimination n.s. in Whites. In ethnic minority individuals, discrimination w/ flatter slope

Notes: BMI = body mass index; BP = blood pressure; CAR = cortisol awakening response; LGB = Lesbian, Gay, and Bisexual; med = medication; n.s. = not significant; OC = oral contraceptives; pCRH = placental corticotropin releasing hormone; sCORT = salivary cortisol; TSST = Trier Social Stress Test.

[a]Exclusion criteria applicable to any study (e.g., insufficient saliva) or those related to participants not following study protocol are not listed.

[b]Structural Stigma is an index consisting of a) density of same-sex partner households, b) proportion of Gay Straight Alliances per public high schools in the state, c) state-level policies related to sexual orientation, d) public opinion toward sexual minorities in each state (Hatzenbuehler & McLaughlin, 2014).

[c]Attributed oppression (or racism) is oppression attributed to an oppressive social group by the respondent (Kaholokula et al., 2012).

CHAPTER 3:

Context Matters: Ethnicity, Discrimination and Stress Reactivity

Abstract

Exposure to chronic discrimination is associated with increased morbidity and mortality. In terms of biobehavioral pathways linking discrimination with health outcomes, much work has focused on the cardiovascular system, with fewer studies addressing the hypothalamus-pituitary-adrenal (HPA) axis. In this study associations between Latino ethnicity, experiences of discrimination, and cortisol responses to an acute laboratory stressor were tested. One hundred and fifty eight individuals (92 female, 66 male) between the ages of 18 and 29 years participated in the study. Salivary cortisol was measured before and repeatedly after the laboratory stressor (the Trier Social Stress Test), and prior discrimination experiences were measured with the Experiences of Discrimination Scale. A moderated mediation emerged, such that Latino ethnicity predicted heightened cortisol reactivity through discrimination experiences (mediator), and this effect was further moderated by sex, with a significant indirect effect only among males. Of note, the direct path from Latino ethnicity to cortisol reactivity did not emerge as significant. Findings suggest that Latino ethnicity and discrimination interact to predict cortisol dysregulation, which implies that an appropriate model for understanding the sociocultural problem of minority health discrepancies cannot simply rely on the effects of ethnicity or discrimination alone.

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, gender, nationality, religion or disability. Exposure to chronic discrimination has been associated with increased mortality and a wide range of physical and mental health outcomes (Paradies et al., 2015; Williams & Mohammed, 2009), and there is evidence that the stress resulting from discrimination may contribute to explaining health disparities in ethnic minority populations that cannot be accounted for by sociodemographic variables alone, such as socioeconomic status and health insurance. (Williams, 1999; Williams & 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 & Smart Richman, 2009). Much less work has been conducted on the link between discrimination and dysregulations in the stress-responsive hypothalamus-pituitary-adrenal (HPA) system. 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 glands; cortisol can bind to receptors on the pituitary, hypothalamus and higher order brain structures, regulating its own activity by a negative feedback system (Tsigos & Chrousos, 2002). 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 stress-related disease (Chrousos & Gold, 1992). Thus, it appears that more empirical investigations into discrimination experiences and HPA axis dysregulations are needed.

In terms of measuring HPA axis activity, studies have often used laboratory stress protocols and assessed individual's cortisol responses to this acute stressor. Psychobiological stress reactivity is thought to reflect vulnerability to stress and to explain some of the variability in the link between stress and disease (Boyce et al., 1995; Cohen & Manuck, 1995; Lovallo & Gerin, 2003). The literature on discrimination and cortisol responses to acute stressors, which are reviewed in more detail elsewhere (Busse et al., under review, Chapter 2), is small. Studies consistently point toward altered cortisol reactivity with discrimination experiences, but the direction of the effect has varied. It appears that studies inducing acute experiences of discrimination in the laboratory (i.e., the laboratory stressor includes elements of discrimination) find more pronounced cortisol responses with discrimination (Hehman & Bugental, 2015; Townsend, Eliezer, Major, & Mendes, 2014; Townsend, Major, Gangi, & Mendes, 2011). Conversely, studies comparing cortisol responses between individuals with and without a history of discrimination find more blunted responses with discrimination (Hatzenbuehler & McLaughlin, 2014; Jamieson, Koslov, Nock, & Mendes, 2013; Richman & Jonassaint, 2008).

One issue that needs to be addressed to better understand the link between discrimination and health is that discrimination is more frequently experienced in marginalized groups, including under-represented ethnicities. Members of the Latino community are often targets of discrimination, and commonly report being discriminated against by their peers, their teachers, and others based on their language skills, immigration status, socioeconomic status and skin color (Edwards & Romero, 2008). While pervasive, it is also apparent that the experience of

discrimination cannot be reduced to membership in a social category alone; the psychological process at stake is discrimination itself. In fact, there is empirical evidence suggesting that discrimination can be associated with HPA axis dysregulation regardless of race (e.g., Skinner, Shirtcliff, Haggerty, Coe, & Catalano, 2011). Other studies point toward the possibility that race and discrimination may interact. For example, one study showed that racial differences in HPA axis activity cannot be explained by discrimination experiences alone (e.g., Martin, Bruce, & Fisher, 2012). However, the exact nature of these interactive processes remains poorly understood. One other possibility is that membership in a stigmatized group disproportionately exposes individuals to discrimination, which in turn may impact HPA axis function and ultimately health. Thus, the present study sets out to investigate whether social context, in this case being of Latino ethnicity, is associated with more frequent experiences of discrimination, and in turn, HPA axis dysregulation.

Method

Participants

The sample consisted of 158 individuals (92 female, 66 male) between the ages of 18 and 29 years (M = 20.49, SD = 2.08). Ethnicity varied and included Latino (53.8%), White (14.6%), Asian (13.9%), Mixed Ethnicity (6.3%) and Other Ethnicity (11.4%). Participants came from various educational backgrounds; about a third reported that their parents had a college degree (mothers: 31.6%; fathers: 38.6%), and about a fourth that their parents had middle school education or less (mothers: 29.8%; fathers: 24.8%). Mean years of education was 12.39% (SD = 5.30) for mothers and 13.29 years for fathers (SD = 5.33). In terms of socioeconomic status, 15.8 percent identified their families as lower working class (unskilled workers, employed off-and-on), 43.7 percent as lower middle class (skilled trade, steady employment), 17.7 percent as upper

working class (skilled workers, steady employment), and 22.8 percent as upper middle class (professionals, high earners). 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.

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. Cortisol typically peaks 30 minutes after awakening and decreases steadily throughout the day (Pruessner et al., 1997). Study days were scheduled to begin at 2pm so that the stress task occurred during the time of day with minimal natural fluctuation.

After a 15-minute 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, Pirke, & Hellhammer, 1993). The TSST consists of a 5-min mock job interview and a 5-min mental arithmetic task in front of a two neutral, non-supportive expert evaluators of diverse cultural backgrounds (e.g., Latino, European, East Asian, mixed background) and both genders. Including the instruction and preparation period, the TSST lasted 15 minutes. 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 minutes. 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 a modest monetary incentive.

Measures

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 minutes at 2,000g and 4°C. Free cortisol was determined in duplicate by an enzyme immunoassay (IBL-America, Minneapolis, Minnesota). The sensitivity of the assay is 0.033 nmol/L, and the dynamic range is 0 to 82.77 nmol/L. Inter-and intra-assay coefficients of variance are reported at 4.9% and 4.1%, respectively.

Discrimination. Discrimination experiences were assessed with the Experiences of Discrimination Scale (EOD, Krieger, Smith, Naishadham, Hartman, & Barbeau, 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). The EOD has shown acceptable internal consistency ($\alpha = 0.74$).

Statistical Methods

Summary scores were computed for the EOD, such that higher scores indicated more frequent discrimination experiences. To obtain a single variable reflecting salivary cortisol responses to the TSST, the pre-TSST cortisol value from the maximum cortisol value obtained at any time after the TSST (1 min to 90 min samples) was subtracted. This variable indexed the maximum cortisol increase experienced by a participant in response to the TSST (termed *maximum cortisol increase*). Cultural background was dummy coded with Latinos coded 1 and

non-Latinos coded 0. For ease of interpretation, the scores for all predictor variables were mean centered. Hypotheses were tested using the moderated mediation model with model 14 of the PROCESS macro for SPSS (Hayes, 2013). This analysis was conducted with 5,000 bootstrap samples to provide an index of the approximate size of the moderated mediation effect at the population level (Hayes, 2015). Significance for direct and indirect paths were considered significant when the 95% bias-corrected bootstrap confidence interval excluded zero.

Results

Preliminary Analyses

Past experiences of discrimination were reported by 79.1% of participants. Among those experiencing discrimination, 44.3% reported racial-ethnic factors as the major source of discrimination (race: 31.6%; shade of skin color: 7.6%; ancestry or national origin: 5.1%), followed by age (14.6%), gender (8.2%), education or income level (8.2%), height or weight (5.7%), sexual orientation (2.5%) and Other (15.2%). Reports of discrimination based on racial-ethnic factors were particularly prevalent among Latinos who represented 91.7% of those experiencing discrimination based on skin color, 68.0% of those experiencing racial discrimination, 50.0% of those experiencing discrimination based on ancestry or national origin. These statistics validate the choice to group this sample into Latinos and non-Latinos for all future analyses in the present study.

Data were first examined for cultural background (Latino vs. non-Latino) or sex (male vs. female) differences in discrimination and cortisol. Latinos reported significantly more discrimination than non-Latinos, $t(141) = -4.42$, $p < .001$, and males marginally more discrimination than females, $t(154) = 1.68$, $p = .10$, but no other significant differences emerged (all $p > .26$). Intercorrelations between major study variables were then computed in the full

sample, and the only correlation emerging as significant was that between the EOD frequency scale and the maximum cortisol increase ($r = .17$, $p < .05$).

Hypothesis Testing

The full moderated mediation model including cultural background, discrimination (EOD frequency) and sex explained 6.67% of the variance in the maximum cortisol increase, F (4,142) = 2.53, $p < .05$ (See Figure 2). A direct effect of cultural background on discrimination, $b = 4.30$, $SE = .96$, $p < .001$, *CI*: 2.41, 6.20, was observed, with Latinos experiencing more discrimination than non-Latinos. There was also a direct effect from perceived discrimination to the maximum cortisol increase, $b = 1.75$, $SE = .66$, $p < .01$, *CI*: .43, 3.06, which was moderated by sex, $b = -.84$, $SE = .42$ (-1.66, -.02). However, no direct effect of cultural background on maximum cortisol increase, $b = -1.80$, $SE = 2.74$ (-7.22, 3.62) was found, suggesting that race alone is not a significant predictor of cortisol dysregulation. As hypothesized, analyses revealed a conditional indirect effect such that Latino ethnicity predicted the maximum cortisol increase through discrimination experiences (mediator), an effect moderated by sex. Specifically, sex moderated the path in the model from discrimination to maximum cortisol increase. This moderation effect was driven by the male participants, $b = 3.90$, $SE = 1.89$ (.94, 8.61), not by the female participants, $b = .29$, $SE = 1.47$ (-1.87, 4.22), as further confirmed by the non-significant bootstrap index of moderated mediation, $b = -3.60$, $SE = 2.37$, (-8.71, .74).

Discussion

The present study suggests that Latinos, who are disproportionately exposed to experiences of discrimination, are, in turn, predisposed to more pronounced cortisol reactivity, a finding that is particularly true for men. These findings make two key contributions to the literature. First, cultural background alone was not sufficient to predict the changes in cortisol

reactivity that resulted from experiences of discrimination. Latinos in this sample experienced a significantly higher degree of discrimination than non-Latinos, but it was the interaction of ethnic background with discrimination experience that predicted higher reactivity. This suggests that studies using race as a proxy for discrimination may not properly capture the sociocultural processes driving the association, as has been argued before (Cho, 2006; La Veist, 1996). Second, studying discrimination in isolation is not sufficient to understand the processes at play either. The two significant direct effects in the model, from Latino ethnicity to discrimination and from discrimination to cortisol reactivity were not simply separate paths, but are tied together by an overarching conditional indirect effect. Latinos are disproportionately affected by discrimination, which contributes to discrimination-related alterations in HPA axis function. In other words, the sociocultural context of being Latino matters.

There was also evidence in the 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, Jackson, & Rivera-Olmedo, 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, McDonald, Molina, & Sidanius, 2010). In the present context it could also be speculated that men may perceive discrimination experiences as more disempowering than women do, or that women may have more access to social support that could buffer the stress associated with experiencing discrimination.

The association between discrimination and altered cortisol reactivity that emerged in this sample is very much in line with previous empirical work, although the direction of the effect

has varied in prior studies. As covered in a recent review (Busse et al., under review, Chapter 2), there is evidence that studies conceptualizing discrimination as an acute event were associated with more pronounced cortisol responses (Hehman & Bugental, 2015; Townsend et al., 2014; Townsend et al., 2011). Conversely, studies assessing discrimination in terms of prior, chronic exposure, were more likely to report blunted responses with discrimination (Hatzenbuehler & McLaughlin, 2014; Jamieson et al., 2013; Richman & Jonassaint, 2008). The results in this study do not neatly fit into this pattern; past experiences of discrimination were assessed, and yet more pronounced cortisol reactivity were observed. It may matter how far in the past experiences of discrimination have occurred and how significant the experiences were for the individual. It has been theorized that initially, acute stress exposure leads to heightened HPA axis responses, whereas chronic stress exposure will result in wear-and-tear on the HPA system and ultimately lead to blunted cortisol reactivity. The people who participated in this study were still young, and it is possible that their experiences of discrimination were either not long-lasting enough or perhaps also not severe enough to lead to a chronic stress HPA axis profile. Moreover, 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 only other study on cortisol reactivity using a questionnaire to measure discrimination found an effect only for structural stigma, but not for perceived discrimination among LGB youth (Hatzenbuehler & McLaughlin, 2014). Specific variations in TSST procedure may also have been a factor (Yim, Quas, Cahill, & Hayakawa, 2010). The TSST observers in this study, the majority of whom were Latino, may have influenced the participants' stress responses, but not in the expected direction. There is evidence that same-race rejection may elicit greater cortisol responses than cross-race rejection (Jamieson et al., 2013). Future analyses may determine if this was a moderating factor.

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. In terms of the chronicity of the discrimination experience, studies specifically assessing the occurrence of recent and more distant, lifetime experiences of discrimination experiences would be a good first step. Longitudinal, prospective studies are also needed to bring further clarity to this issue. Finally, Latino ethnicity, which represents one group that experiences disproportionate exposure to discrimination, was studied. However, many other social groups are at the receiving end of 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.

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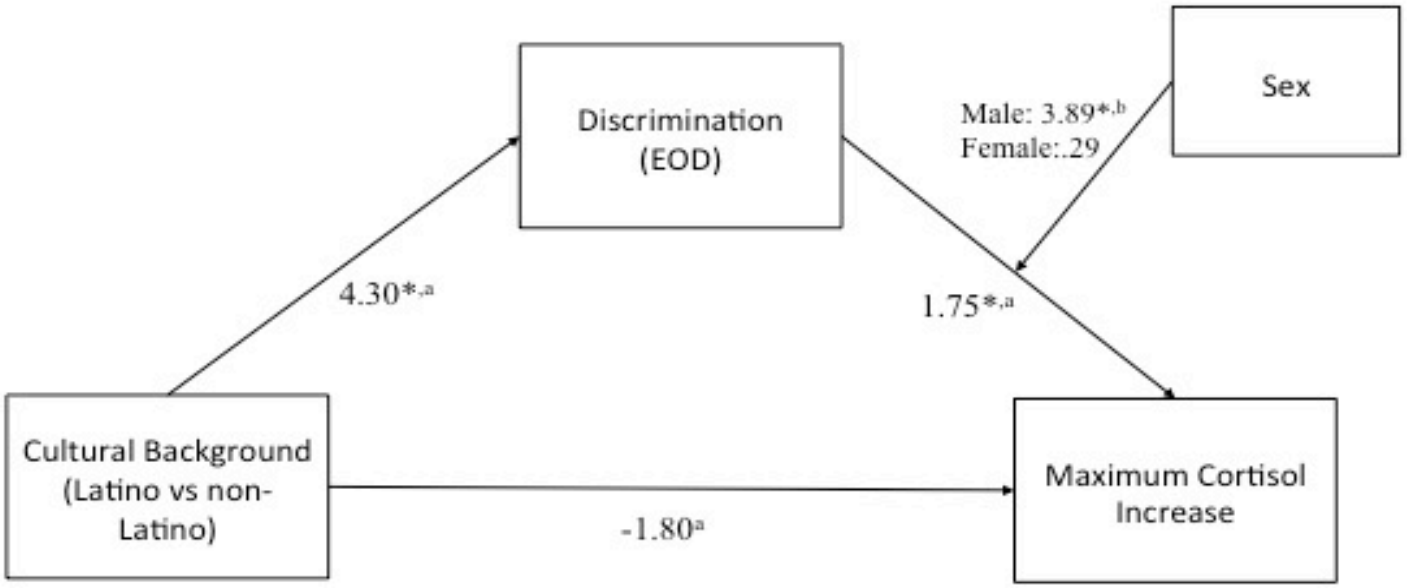

Note: N = 147, effects based on 5,000 bootstrapped re-samples. Asterisks indicate significant effects in the full model. [a]Coefficients for direct effects; [b]Coefficients for conditional indirect effect of cultural background on maximum cortisol increase at values of the moderator.

Figure 2. Conditional Indirect Effect of Cultural Background on Maximum Cortisol Increase in Response to the Trier Social Stress Test.

CHAPTER 4: OVERALL DISCUSSION

Overall Discussion

Previous reviews of the literature on the pathways between discrimination and health have focused primarily on the autonomic—cardiovascular outcomes relationship. However, a growing number of studies have begun to also study the role of the HPA axis in this context. Thus, the first goal was to systematically examine the existing literature on the discrimination—HPA axis link, as this has been implicated in adverse *mental* health outcomes. The second goal was to advance the literature using experimental methods to examine if discrimination mediated the relationship between cultural background and cortisol response to a stressor. Additionally, sex as a potential moderator was explored.

In the systematic review (Chapter 3), 10 experimental and 17 observational studies (two longitudinal) were identified and included. Most of the studies found a relationship between experiences of discrimination and cortisol or other indicators of HPA activity (DHEA or placental CRH). Timing and chronicity of the discrimination experience were important factors in the experimental studies. Experimental protocols that simulated a discrimination experience, and thus conceptualizing discrimination as an acute event, showed increased cortisol responses (Hehman & Bugental, 2015; Townsend et al., 2014; Townsend et al., 2011). Studies that conceptualized discrimination as chronic by measuring past experiences of discrimination found more blunted cortisol responses to a non-discriminatory laboratory stress task (Hatzenbuehler & McLaughlin, 2014; Jamieson et al., 2013; Richman & Jonassaint, 2008).

Chronicity of the discrimination experience is another factor linked with HPA activity. Overall, past experiences of discrimination, typically assessed by questionnaires, are associated with flatter diurnal cortisol slopes (Adam et al., 2015; Skinner et al., 2011) and a lower CAR (Adam et al., 2015). These conclusions align with results from a meta-analytic review of the

effects of stress and the HPA axis (Miller et al., 2007) which concludes that past chronic stress is associated with lower than normal morning cortisol output and higher secretion as the day progresses. However, other observational studies had more conflicting or inconsistent results, but these findings could be reconciled by taking into account the moderating factors identified in the studies.

The second project investigated the relationship between ethnicity, discrimination experiences, and cortisol reactivity. Although Latinos experienced more discrimination than non-Latinos, simply being Latino was not enough to predict increased cortisol response to an acute stressor. Rather, Latino ethnicity predicted discrimination experiences (the mediator), which predicted heightened cortisol reactivity. This implies that cultural background interacts with discrimination experiences to influence cortisol reactivity.

This mediation effect was moderated by sex, such that the indirect effect of discrimination on cortisol only occurred in males. There are several possible explanations for why this occurred. First, it is possible that men feel more disempowered when experiencing discrimination. Social support may also act as a buffer for females experiencing discrimination. Familism, a cultural value characterized by close family relationships and emotionally positive social interactions, is particularly high in Latinas (Campos et al., 2008). Future research should directly examine whether familism and other aspects of Latino culture (e.g., acculturation, bicultural identity) are resilience factors or liabilities when encountering discrimination.

At first glance, the pattern of cortisol response to the acute stressor in Study 2 seems to contradict the findings in the review (Busse et al., 2016) that associates chronic discrimination exposure to blunted cortisol responses to acute stressors. Study 2, which showed elevated cortisol responses to the TSST in males with high levels of past discrimination contradicts

studies in the review (Hatzenbuehler & McLaughlin, 2014; Jamieson et al., 2013; Richman & Jonassaint, 2008). There are several plausible explanations for these contradictory findings. It is possible that the young, college-educated sample, primarily from Southern California, have not yet experienced enough stress or discrimination to reach the "turning point" where their stress response becomes blunted.

The discrimination questionnaire used in this study may also be a factor as to why these results conflict with past research. The EOD is one of the most widely used and well-validated instruments to assess past discrimination; however, it may have limited utility with student populations, many of whom have never applied for a job, housing, or a bank loan. The EOD also does not assess the relative severity of the experiences, or how the victim attributes the cause of the discrimination (e.g., racism, age, sexual orientation). All types of discrimination may not be equal, and individuals belonging to multiple targeted groups (e.g., black and transgender) may attribute discrimination experiences to one identity or both. It has been shown that belonging to multiple discriminated groups (i.e., *intersectionality*) is associated with worse physical and mental health than belonging to a single group (Grollman, 2012). Research on how intersectionality and the discrimination associated with it may influence the stress response is an area for future research.

The HPA axis is an important pathway to understanding how our social experiences, particularly the negative experience of discrimination, can impact health. Discrimination may be a particularly insidious social experience, and thus especially toxic, because it combines elements of social rejection, is typically chronic/ or long-lasting, possible life-threatening, uncontrollable, and damaging to one's social standing. This uncontrollability aspect has been shown to be associated with blunted cortisol profiles (Gold & Chrousos, 2002).

The characteristics of specific discrimination incidents or experiences may be vital in understanding how they influence the HPA axis. For example, discrimination experiences that primarily threaten social standing may invoke an HPA response that reaches a peak rather quickly but then recedes back to baseline (Dickerson & Kemeny, 2004); alternately, being exposed to news reports of members of your cultural group being targeted by police may invoke feelings of uncontrollability, and these experiences may be more associated with a blunted cortisol profile (Miller et al., 2007).

Discrimination, not ethnicity, is a more important factor in understanding the HPA response to stress. However, it is impossible to separate discrimination and ethnicity, and they may interact. For example, strong family ties and social support in Latinos may provide a buffer from the harmful effects of stress (Campos et al., 2008).

The observational studies identified in this review primarily relied upon retrospective accounts of discrimination experiences. Despite evidence that perceived discrimination is a stressor, questionnaires assessing how one responds to a broad range of discrimination experiences from a stress reactivity perspective are non-existent. Existing perceived discrimination or racism questionnaires assess the frequency of discriminatory events (e.g., Krieger, Smith, Naishadham, Hartman, & Barbeau, 2005), coping responses (Williams, Yu, Jackson, & Anderson, 1997a), or types of maltreatment (e.g., Brondolo et al., 2005). Questionnaires that attempt to measure discrimination stress are specific to racial or ethnic discrimination (Contrada et al., 2001; Utsey,1998). Discrimination may occur over a lifetime, and people may not remember events that occurred years ago.

Certain factors not covered in this review may also be implicated in the discrimination—health relationship. First, discrimination may limit access to healthy neighborhoods and living

situations. Segregated communities are common in many parts of the world, including industrialized nations, and ethnic minorities are more likely than Whites to live in these areas. Data from the American Community Survey and from the 1990 and 2000 U.S. Census found that low-income African Americans were more likely than their White counterparts to live in high-poverty areas (Lichter, Parisi, & Taquino, 2011). Disenfranchised groups in poorer areas have fewer economic resources, and the link between low SES and poorer health is well established (Adler et al., 1994).

Discrimination may also limit access to medical care. In 2011 nearly 48 million Americans lacked health insurance (Kaiser Family Foundation, 2012), with minorities disproportionately represented among the uninsured (Kaiser Family Foundation, 2013). Because health insurance in the United States is often tied to employment, and ethnic minorities face higher unemployment due to discriminatory hiring practices (Pager, Western, & Bonikowski, 2009), being uninsured may be an additional consequence of discrimination. Ethnic minorities are also less likely to seek medical treatment even if they have medical insurance. A study in Sweden, a country that has universal health insurance coverage, found that perceived discrimination prevented patients from seeking medical care (Wamala, Merlo, Boström, & Hogstedt, 2007). Ethnicity, age, gender, and religion were all cited in this study as the basis for the discrimination.

When minorities do receive healthcare, their care is more likely to be of lower quality than the care received by their White counterparts. Data from the 2003 California Health Interview Survey showed that ethnic minorities were more likely to report that minority/racial status had a negative effect on the medical care they received, while SES and insurance status were protective factors against discrimination (Lauderdale, Wen, Jacobs, & Kandula, 2013). Past

experiences of discrimination in healthcare settings may impact communication between patients and healthcare providers, and this may have implications for adherence to treatment and follow-up care. Using a version of the Williams Everyday Discrimination measure adapted for healthcare settings (Williams, Yu, Jackson, & Anderson, 1997), 100 African American and 253 White participants and their orthopedic surgeons were audio recorded during clinic appointments. Recordings were coded for informational/instrumental and socioemotional/ affective communication content. As expected, African Americans reported more past experiences of discrimination in healthcare settings. Moreover, these past experiences influenced patient-provider communication, primarily through non-verbal and affective aspects of communication, in subsequent healthcare visits (Hausmann et al., 2011). Healthcare providers treating patients with past discriminatory experiences would mirror their patients' negative affect and emotional tone, which contributes to a negative experience and may make it less likely for the patient to seek future care, trust their provider, or adhere to treatment.

Third, feeling discriminated against may lead people to participate in unhealthy behaviors such as smoking, heavy alcohol use, and not maintaining a healthy diet. In a study of 179 female, mostly White college students, students who experienced more sexism were more likely to binge drink and smoke cigarettes, and this relationship was mediated by personal distress, indicating that people engage in harmful health behaviors as a way to cope with feelings of discrimination (Zucker & Landry, 2007). Discrimination may also prevent people from engaging in health promoting behaviors such as cancer screening. Data from the 2003 and 2005 California Health Interview Survey indicate that women who perceived racial or ethnic-based medical discrimination within the last 5 years were less likely to be screened for colorectal and breast cancers than women who did not perceive any medical discrimination (Crawley, Ahn, &

Winkleby, 2008). These results were also found for men but only when they had a usual source of healthcare (e.g., primary care provider), leading the authors to speculate that having a regular healthcare provider increased exposure to discriminatory experiences.

Future directions

The review here only included two longitudinal studies, one using an ecological momentary assessment protocol. Future studies that gather discrimination experiences in real-time would be able to accurately capture nuances of the experience as well as the timing, chronicity, emotional reactions, and coping responses. All of these factors are important variables in how the body responds to stressful situations. Future analyses in Study 2 should explore the concept of mixed identity, whether individuals identify with only one of their cultures or with both, and how this may be associated with their perceptions of discrimination and their subsequent stress response.

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