



## Review article

## Racial discrimination and cortisol output: A meta-analysis

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## ABSTRACT

**Rationale:** Although the relation between stress and physiology is well documented, attempts at understanding the link between racial discrimination and cortisol output, specifically, have produced mixed results, likely due to study characteristics such as racial/ethnic composition of the samples (e.g., African American, Latino), measures of discrimination, and research design (e.g., cross-sectional, experimental). **Objectives:** To estimate the overall association between racial discrimination and cortisol output among racial/ethnic minority individuals and to determine if the association between racial discrimination and cortisol output is moderated by age, race/ethnicity, type of discrimination measure, sex, and research design.

**Results:** Using a random effects model, the overall effect size based on  $k = 16$  studies (19% unpublished) and  $N = 1506$  participants was  $\bar{r} = 0.040$ , 95% CI =  $-0.038$  to  $0.117$ . Studies were conducted predominantly in the U.S. (81%). Notably, experimental studies ( $\bar{r} = 0.267$ ) exhibited larger effect sizes compared to non-experimental studies ( $\bar{r} = -0.007$ ). Age, race/ethnicity, type of discrimination measure, and sex did not moderate the effect sizes.

**Conclusion:** This meta-analysis provides evidence that the measurement of the association between racial discrimination and cortisol is complex, and it offers valuable insight regarding methods and designs that can inform future research on this topic. Limitations and future directions are discussed.

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## 1. Racial discrimination and cortisol output: a meta-analysis

A growing body of research supports the notion that racial discrimination is associated with negative physical and mental health outcomes among racial/ethnic minority individuals (Lewiss et al., 2015; Mays et al., 2007; Williams and Mohammed, 2009). Across 293 studies, a meta-analysis identified that experiences of racism were significantly associated with depression, psychological distress, anxiety, internalizing symptoms, negative affect, post-traumatic stress disorder (PTSD), suicide ideation, low self-esteem, decreased life-satisfaction, and poorer overall physical and general health (Paradies et al., 2015). However, less is known about the specific neuroendocrine pathways underlying the negative association between racial discrimination and physical and mental health. Although recent evidence has shown that racial

discrimination can trigger a cascade of physiological changes, such as activating the hypothalamic-pituitary-adrenal (HPA) axis, which likely contribute to poor health outcomes (Clark et al., 1999; Harrell et al., 2011), the emerging literature on the effects of racial discrimination on the HPA axis is inconclusive. This inconclusivity is because studies vary in terms of reported outcomes, sample composition (e.g., age and race/ethnicity), and research design. The goal of this meta-analysis was to examine the association between racial discrimination and cortisol output based on the current research and to attempt to explain some of the observed variability among effect sizes through moderator analyses.

## 1.1. Racial discrimination

Racial discrimination is the behavioral component of racism, or the differential treatment of others labeled as inferior based on phenotype characteristics and/or ethnic affiliation (see Clark et al., 1999; Jones, 1997); it is defined as the systematic actions of dominant group members that result in unfair, differential, and negative treatment of subordinate racial/ethnic group members (Williams et al., 2003). Several characteristics of racial

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discrimination make it a particularly relevant and impactful experience among racial/ethnic minority members. First, it is a widespread, commonplace phenomenon with 60.9% reporting day-to-day discrimination (Kessler et al., 1999), and 87% African American and 90% Caribbean Black adolescents reporting at least one discrimination incident in the past year (Seaton et al., 2008). Second, it operates at multiple levels including individual, institutional, and cultural (Jones, 1997). Third, it is multidimensional in that racial discrimination occurs in schools, workplaces, and policies, and indirectly through historical trauma (Williams and Mohammed, 2009).

### 1.2. Physiological reactivity and cortisol output

One physiological change associated with racial discrimination is the activation of the HPA axis (e.g., Harrell et al., 2011). When the HPA axis is activated in response to stress, the central nervous system stimulates the paraventricular nucleus of the hypothalamus and releases corticotrophin hormones and arginine vasopressin to the pituitary gland. In turn, corticotrophin hormones and arginine vasopressin stimulate the release of adrenocorticotrophic hormones, leading to the secretion of glucocorticoids (i.e., cortisol) from the adrenal cortex (Gunnar and Quevedo, 2007). This increase of cortisol beyond basal concentrations decreases HPA axis activity through negative feedback in which glucocorticoid receptors send inhibitory signals back to the paraventricular nucleus to suppress the production of corticotrophin hormones and terminate the HPA axis stress response (Gunnar and Quevedo, 2007).

Cortisol is also secreted from the HPA axis in daily circadian rhythms, or diurnal rhythms, in which cortisol levels are high at waking with a 50–60% increase 30–40 min post waking and then decline throughout the day, reaching the lowest point around midnight (Levine et al., 2007). This rapid increase of cortisol post awakening is referred to as the cortisol awakening response and is proposed to be related to the switching of activity between – and reactivation of – neurobiological systems involved in pre- and post-awakening processes (see Clow et al., 2010). To quantify diurnal patterns of cortisol output researchers calculate the slope (i.e., diurnal slope), or the rate of decline from waking levels of cortisol to levels assessed before bedtime. There is accumulating evidence that flattening patterns of diurnal slopes are related to poor overall mental and physical health, and to a lesser extent may be an indication of altered HPA axis functioning (Miller et al., 2007).

While an increase in cortisol secretion may assist individuals in adapting to particular situations, chronic activation can alter the structure and function of neurobiological processes and lead to long-term alterations and disease (McEwen and Seeman, 1999). For instance, chronic activation of the HPA axis can expose bodily tissues to excessive concentrations of cortisol, resulting in tissue damage (McEwen, 1998), and can put strenuous pressure on the feedback mechanisms of the HPA axis by increasing activity levels or decreasing inhibitory signals to the paraventricular nucleus (Theil and Dretsch, 2011). Consequentially, individuals with higher levels of cortisol when lower levels are expected, or with lower levels of cortisol when higher levels are expected, are at increased risk for diabetes, hypertension, immune related sickness, cognitive impairments, mental health disorders, and suicidal behavior (Gunnar and Quevedo, 2007; McEwen, 1998; O'Connor et al., 2016; Shields et al., 2015). In a meta-analysis, Adam et al. (2017) identified that, across 26,167 individuals, flatter diurnal slopes were significantly associated with poorer physical and mental health outcomes.

### 1.3. Racial discrimination and cortisol output

Recently, researchers have begun to examine the link between racial discrimination and biological systems including physiological activity (e.g., Busse et al., 2017; Levy et al., 2016). The biopsychosocial model of racism posits a complex relation between experiences of racial discrimination and amplified physiological stress responses in which constitutional (e.g., skin tone, family health history), sociodemographic (e.g., socioeconomic status), and psychological and behavioral factors function interrelatedly to affect interpretations of racially charged events and coping responses; these in turn, exacerbate physiological activity (Clark et al., 1999). Put differently, the relation between racial discrimination and physiological activity may differ across individuals as several factors likely mediate this relation. To add to this complexity, Harrell et al. (2011) proposed multiple psychophysiological pathways through which racial discrimination is associated with physiological activity, including several psychological mediators (e.g., stress and coping, worry and rumination) and critical brain regions (e.g., amygdala, prefrontal cortices). Depending on the pathway activated, racial discrimination may lead to different physiological outcomes (Harrell et al., 2011). Thus, the relation between racial discrimination and physiological activity is complex and multifaceted.

Past research has documented an association between racial discrimination and various measures of cortisol output, yet the magnitude and direction of this relation is still unclear (see Busse et al., 2017; for a qualitative review). The variability in outcomes are convoluted by sample characteristics and research methods. For instance, some studies have reported flatter diurnal slopes for African American/Black adults (Adam et al., 2015) and across a diverse sample of racial/ethnic minority (i.e., African American/Black, Hispanic/Latino, Pacific Islander, multiethnic/multiracial) young adults (Zeiders et al., 2014), whereas null findings have been reported for Mexican American adolescents (Zeiders et al., 2012). Interpretation of these results is also complicated by the fact that these studies used different measures of racial discrimination, including the Racism and Life Experiences Scale (Harrell, 1997), the Everyday Discrimination Scale (Williams et al., 1997), the Brief Perceived Ethnic Discrimination Questionnaire-Community Version (Brondolo et al., 2005), and study-specific measures (e.g., Wong et al., 2003).

The moderating role of sample characteristics and research methods have been documented in past meta-analyses on discrimination and health and well-being. Pascoe and Smart Richman (2009) reported that the association between discrimination and psychological well-being and physical health was not moderated by sex or race/ethnicity. In contrast, two other meta-analyses indicated that the association was larger for Asian and Latino participants compared to African American participants (Paradies et al., 2015; Schmitt et al., 2014). Dolezsar et al. (2014), additionally, found that the relation between discrimination and hypertensive status was larger for Black compared to Hispanic participants and in samples that included a higher percentage of males. In addition, two meta-analyses reported a larger association for children compared to adults (Lee and Ahn, 2012; Schmitt et al., 2014), and one meta-analysis reported a larger association for older adults (Dolezsar et al., 2014). In regards to the type of racial discrimination measure, Paradies et al. (2015) reported larger associations between racial discrimination and physical health for the Everyday Discrimination Scale (Williams et al., 1997) and Experiences of Discrimination (Krieger et al., 2005) than the Perceived Racism Scale (McNeilly et al., 1995). Nonetheless, it remains unclear if sample characteristics and research methods moderate the association between racial discrimination and cortisol output, specifically.

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