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Associations among daily stressors and salivary cortisol: Findings from the National Study of Daily Experiences

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Summary While much research has focused on linking stressful experiences to emotional and biological reactions in laboratory settings, there is an emerging interest in extending these examinations to field studies of daily life. The current study examined day-to-day associations among naturally occurring daily stressors and salivary cortisol in a national sample of adults from the second wave of the National Study of Daily Experiences (NSDE). A sample of 1694 adults (age = 57, range = 33–84; 44% male) completed telephone interviews detailing their stressors and emotions on eight consecutive evenings. Participants also provided saliva samples upon waking, 30 min post-waking, before lunch and before bed, on four consecutive interview days resulting in 5995 days of interview/cortisol data. Analyses revealed three main findings. First, cortisol AUC was significantly higher on stressor days compared to stressor-free days, particularly for arguments and overloads at home, suggesting that daily stressors are associated with increased cortisol output, but that not all daily stressors have such an influence. Second, individuals reporting a greater frequency of stressor days also exhibited a steeper diurnal cortisol slope. Finally, daily stressor–cortisol associations were unaltered after adjustment for daily negative affect and physical symptoms. Our discussion focuses on the influence of naturally occurring daily stressors on daily cortisol and the role of daily diary approaches for studying healthy cortisol responses to psychosocial stressors outside of traditional laboratory settings.

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1. Introduction

Daily stressors are minor events, such as arguments or work deadlines that arise out of the routines of day-to-day living, and have both immediate and cumulative effects on physical and psychological well-being (Lazarus, 1999; Zautra, 2003; Almeida, 2005). Previous research has shown that the experience of daily stressors is associated with increases in negative affect and physical symptoms (Almeida et al., 2005; Stawski et al., 2008; Piazza et al., 2013; Charles et al., 2013). While the self-reported emotional and physical toll of daily stressors has been well-demonstrated, evidence demonstrating the effects of daily stressors on stress physiology, specifically naturally occurring cortisol levels, is comparatively scant. Using data from the National Study of Daily Experiences (NSDE), which combines daily telephone interviews with saliva collection from adults ages 33–84, the current study examines prevalence of daily stressors across midlife and old age and their associations with naturally occurring levels and diurnal rhythms of salivary cortisol.

Stressors contribute to disease risk by taxing biological resources (McEwen, 1998). The hypothalamic–pituitary–adrenal (HPA) axis is thought to be a primary biological system for understanding the effects of psychosocial stressors on health and disease (Kemeny, 2003). Cortisol, a product of the HPA axis, has received considerable attention as a highly useful biomarker because of its sensitivity to psychosocial stress, utility as an indicator of neuroendocrine/HPA-axis health and function (Miller et al., 2007; Hellhammer et al., 2009), and predictor of general health and mortality (Wrosch et al., 2008; Schoorlemmer et al., 2009; Kumari et al., 2011). An important feature of cortisol is its diurnal pattern, reaching its peak within an hour after waking and declining thereafter, until reaching a nadir at approximately midnight (Pruessner et al., 1997; Kudielka et al., 2003). The initial rise is referred to as the cortisol awakening response (CAR), and the decline as the diurnal cortisol slope (DCS). A robust CAR and DCS are thought to reflect healthy HPA axis function (Stone et al., 2001; Adam and Kumari, 2009), whereas hypo- or hyper-activity of these two components are related to adverse physiological outcomes, such as hypertension (e.g., Wirtz et al., 2008) and coronary calcification (Matthews et al., 2006). Moreover, evidence suggests that ongoing stressors, such as low socioeconomic status (e.g., Steptoe et al., 2005) and burnout (e.g., Pruessner et al., 1999; De Vente et al., 2003) are associated with alterations in the CAR and DCS. The current study extends this research by examining associations between minor daily stressors and both the CAR and DCS.

1.1. Field studies of stress and salivary cortisol

Considerable experimental evidence has documented that experiencing moderate psychosocial stressors results in a transient increase in salivary cortisol (Dickerson and Kemeny, 2004). Additionally, researchers have moved outside of laboratory settings, using ecological momentary assessments (EMA), to better understand the temporal covariation of naturally occurring stressful experiences and cortisol (see Kudielka et al., 2012 for review). van Eck et al. (1996), for example, showed that stressors experienced at one sampling

occasion were associated with higher cortisol levels at the next occasion. Similarly, Jacobs et al. (2007) and Smyth et al. (1998) observed that cortisol levels were significantly higher on occasions when participants reported experiencing stressors; however, these effects were accounted for by respondents' momentary affect reports, suggesting that the influence on cortisol operated through emotional responses.

1.2. Stressors, affect and cortisol

Previous studies have examined associations between daily affect and the diurnal rhythm of cortisol among healthy adults. Using EMA designs, higher levels of negative mood are shown to be associated with higher levels of cortisol, with limited evidence for stressors having a separate influence (Hanson et al., 2000; Jacobs et al., 2007; Smyth et al., 1998). Using a daily diary design, Adam et al. (2006) showed that days older adults reported experiencing more intense negative affect were associated with a steeper CAR and a flatter DCS. However, Adam et al. (2006) utilized measures of emotional experience, which can be influenced by the experience of antecedent stressors as well as other psychosocial factors (i.e., personality) and sociodemographic characteristics (i.e., age, gender). Without separate assessments of stressors and affect, it is impossible to distinguish whether cortisol is influenced by stressors or from negative affect possibly related to or independent of the experience of stressors (e.g., Jacobs et al., 2007; Smyth et al., 1998). Thus, it is important to consider the unique influence of stressors and affect for predicting day-to-day variation in cortisol.

We address these issues using a daily diary approach that offers a complementary intensive repeated measures design which typically utilize end-of-day assessments, characterizing a person's day (Bolger et al., 2003). Whereas EMA approaches aim to characterize moments or hours, daily diary approaches aim to characterize days, providing an ideal landscape for examining day-to-day associations among experienced stressors and cortisol levels across the day, as well as the diurnal components of daily cortisol (i.e., CAR and DCS) and indices of total daily cortisol output such as area under the curve (AUC; Pruessner et al., 2003). The present study used the Daily Inventory of Stressful Events (DISE; Almeida et al., 2002) that was developed to combine checklist and interview-based assessments of stressful daily experiences emanating from different domains of life (e.g., interpersonal interactions, work- and home-related responsibilities, and social networks).

1.2.1. Aims of present study

The current study was conducted to investigate the effects of daily stressors on naturally occurring cortisol levels and rhythms using a daily diary approach and drawing on a national sample of midlife and older adults who completed telephone interviews detailing the stressors they experienced. We focus on three specific aims. First, we examine the prevalence and distribution of daily stressors experienced throughout midlife and later adulthood, including interpersonal tensions, work- and home-related overloads, and network stressors. Second, we test the hypothesis that minor daily stressors impact naturally occurring cortisol profiles resulting in higher overall cortisol levels, greater

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