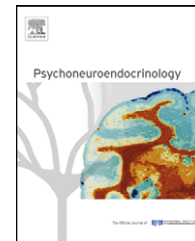




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Loneliness and cortisol: Momentary, day-to-day, and trait associations

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Received 15 November 2008; received in revised form 28 July 2009; accepted 13 August 2009

KEYWORDS

Loneliness;
Cortisol diurnal rhythms;
HPA axis;
Young adults;
Momentary emotion;
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Summary In attempts to understand the social determinants of health, strong associations have been found between measures of loneliness, physiological stress processes, and physical and mental health outcomes. Feelings of loneliness are hypothesized to have implications for physiological stress processes, including activity of the hypothalamic–pituitary–adrenal (HPA) axis. In a community sample of young adults, multilevel modeling was used to examine whether trait and state feelings of loneliness were related to changes in levels of the stress-sensitive hormone cortisol, and whether the associations between loneliness and cortisol were mediated or moderated by the presence of concurrent depression or high levels of chronic life stress. Results indicated that trait loneliness was associated with a flattening of the diurnal cortisol rhythm. In addition, both daily and momentary state variations in loneliness were related to cortisol. Prior day feelings of loneliness were associated with an increased cortisol awakening response the next morning and momentary experiences of loneliness during the day were associated with momentary increases in cortisol among youth who also had high chronic interpersonal stress. Results were significant after covarying current depression, both chronic and momentary reports of stress, and medical and lifestyle covariates. This study expanded on prior work by investigating and revealing three different time courses of association between loneliness and HPA axis activity in young adults: trait, daily and momentary.

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1. Introduction

Loneliness is a feeling that emerges when social relationships are thought to be deficient, and may arise from a perceived

lack of intimacy or lack of companionship (Peplau and Perlman, 1982). Experiencing loneliness can include notions of isolation, disconnection, and “not fitting in”. Loneliness has emerged as an important contributor to physiological stress processes and physical and mental health outcomes (Cacioppo et al., 2003; Steptoe et al., 2004).

Scholars have examined the impact of loneliness on neuroendocrine, immune and cardiovascular responses (Uchino et al., 1996). Loneliness is associated with higher blood pressure (Cacioppo et al., 2002; Steptoe et al., 2004; Hawk-

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ley et al., 2006), and impaired or underactive immune function (Pressman et al., 2005). Studies have found possible links between loneliness and cancer (Fox et al., 1994) and a large epidemiological study found that loneliness was associated with both morbidity and mortality (Herlitz et al., 1998; Seeman, 2000). Feelings of loneliness have been significantly associated with mental and physical health outcomes independent of the size of one's social network or social connections (e.g., see Pressman et al., 2005; Nausheen et al., 2007).

1.1. Loneliness and cortisol

More recently, scholars have started to look at the effect of loneliness on the hypothalamic–pituitary–adrenal axis (HPA axis) as indexed by cortisol levels (Cacioppo et al., 2000a,b; Steptoe et al., 2004; Adam et al., 2006). Much of this research has been on middle-age and older adults, and yet late adolescents and young adults spend the most time alone, and feel lonelier, than any other age group under the age of 60 (Larson, 1990; Rokach, 2001). To our knowledge only three studies to date have examined associations between cortisol and loneliness in the college or young adult years. Their results represented different time courses of loneliness experience and varying measures of cortisol (Cacioppo et al., 2002; Pressman et al., 2005; Adam, 2006). For example, Cacioppo et al. (2002) found elevated mean cortisol levels (based on measures aggregated separately for morning, afternoon and evening) in chronically lonely college students but did not find changes in the shape of diurnal cortisol rhythms across the day between lonely and non-lonely students. They did not examine momentary or daily experiences of loneliness. In contrast, Pressman et al. (2005) found that high levels of momentary or daily experiences of loneliness were associated with elevated morning cortisol and elevated evening cortisol. Adam (2006) found that being alone was associated with higher momentary cortisol in an adolescent population.

While prior studies have examined both trait and momentary influences of loneliness on cortisol, the importance of day-to-day variations in cortisol have only recently been brought to light. A study by Adam et al. (2006) took the novel approach of examining how day-to-day changes in emotional experience (including loneliness) related to day-to-day changes in cortisol diurnal rhythms in older adults. Prior research has generally conceptualized this type of daily variation in diurnal cortisol rhythms as error variation. However, Adam and her colleagues found that emotional experiences and diurnal cortisol patterns covaried in systematic ways. For example, experiences of sadness and loneliness on a particular day predicted a higher cortisol awakening response the following morning.

Given that loneliness and cortisol have been related across multiple time scales in prior research, a goal of the current study was to examine whether momentary state loneliness, day-to-day variation in loneliness, or trait levels of loneliness were the strongest predictors of cortisol activity. Momentary and daily state loneliness were measured using diary reports over the relevant periods of time (moments, days) and trait loneliness was measured using a well-validated trait loneliness questionnaire.

1.2. Psychopathology and chronic life stress: potential mediators or moderators?

Researchers have commonly acknowledged loneliness as a strong correlate of depression (Shaver and Brennan, 1991; Segrin, 1998; Nolen-Hoeksema and Ahrens, 2002; Cacioppo et al., 2006) and that there is great overlap in the constructs of loneliness and depression (Hagerty and Williams, 1999). Studies have also found associations between chronic stress and cortisol, finding stress to be associated with increased cortisol awakening responses (Pruessner et al., 1997; Wüst et al., 2000), and a flattening of the diurnal rhythm (Gunnar and Vazquez, 2001). In this paper, we included major depression, momentary stress, daily stress and chronic interpersonal stress in our models, to examine whether they mediated or accounted for any loneliness–cortisol associations. It can also be hypothesized that having multiple vulnerabilities, such as both loneliness and depression, or high loneliness and multiple life events, might have multiplicative impacts on cortisol activity. As a result, we also examined whether major depression or chronic life stress might have moderating (amplifying) effects on any loneliness–cortisol associations.

In summary, this study sought to understand whether momentary or day-to-day changes in loneliness or chronic, ongoing feelings of isolation and loneliness were more powerfully associated with HPA axis activity. Multilevel linear regressions (HLM) were used to examine these questions, as this approach allowed us to simultaneously examine momentary, daily and between-person differences in cortisol levels in relation to loneliness experienced across each of these three time frames. Several hypotheses were tested in this paper.

First, we hypothesized that youth with heightened levels of trait loneliness would have altered diurnal cortisol rhythms, in particular flatter cortisol slopes across the waking day. Secondly, we hypothesized that there would be day-to-day covariation between loneliness and cortisol such that high levels of loneliness or sadness would be associated with an altered diurnal rhythm the following day, specifically in the form of a higher cortisol awakening response. Finally, we hypothesized that higher momentary lonely/sad (as well as higher momentary stress) would be associated with higher levels of momentary cortisol.

2. Method

2.1. Participants

Participants were recruited from two large public high schools—one in a Chicago suburb and one in the greater Los Angeles area. Students participated in this study as part of their involvement in a larger, longitudinal study on the development of mood and anxiety disorders. Students were selected to participate in the longitudinal study based on their scores on the Neuroticism scale of the EPQ-R (EPQ-R, Eysenck and Eysenck, 1975). In order to increase the number of students in the sample at high risk for the subsequent development of mood and anxiety disorders, students who scored in the upper third on this measure were oversampled, such that two thirds of the participants in the study scored in the upper third on the EPQ-R. Although the larger study was

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