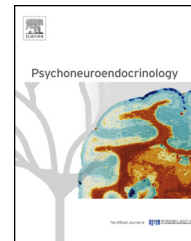




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Lower subjective social status exaggerates interleukin-6 responses to a laboratory stressor



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Summary Growing evidence suggests that lower subjective social status (SSS), which reflects where a person positions himself on a social ladder in relation to others, is independently related to poor health. People who rate themselves lower in status also experience more frequent stressors and report higher stress than those who rate themselves higher in status, and chronic stress can enhance an individual's response to subsequent stressors. To address whether SSS predicted stress-induced interleukin-6 (IL-6) changes, we assessed 138 healthy adults at rest and following the Trier Social Stress Test (TSST). Participants completed the TSST at two study visits, separated by 4 months. People who placed themselves lower on the social ladder had larger IL-6 responses from baseline to 45 min post-stressor ($p = 0.01$) and from baseline to 2 h post-stressor ($p = 0.03$) than those who placed themselves higher on the social ladder. Based on a ratio of subjective threat and coping ratings of the stress task, participants who viewed themselves as

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lower in status also tended to rate the speech task as more threatening and less manageable than those who viewed themselves as higher in status ($p = 0.05$). These data suggest that people with lower perceived status experience greater physiological and psychological burden from brief stressors compared to those with higher perceived status. Accordingly, responses to stressors may be a possible mechanistic link among SSS, stress, and health.

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1. Introduction

People routinely compare themselves to others; a person's sense of self is grounded in part by his or her perception of where s/he stands in relation to other people (Festinger, 1954; Suls et al., 2002; Dickerson and Kemeny, 2004). A common index of perceived standing, called subjective social status (SSS), is measured by ranking oneself on a "social ladder," where higher rungs represent higher status in a social group, such as a school, community, or country (Adler et al., 2000). These self-rankings are often based on objective measures of socioeconomic status (SES) such as income and education, as well as current satisfaction and future financial security in relation to others (Singh-Manoux et al., 2003). For example, a man who views a current low-paying job as a stepping stone to a higher position may rate himself as higher in society than someone who feels unhappily "stuck" with the same pay and doubts his capacity to seek other employment. In this way, SSS encompasses more pieces of an individual's life circumstance than a single measure of objective SES (Adler et al., 2000; Singh-Manoux et al., 2003). Accordingly, SSS has generated growing interest in the past decade as an important predictor of health and well-being (Ostrove et al., 2000; Operario et al., 2004).

Viewing oneself as lower than one's peers is chronically stressful. Compared to those who rate themselves higher in status, those who rate themselves lower in status report greater numbers of ongoing social, financial, work, and relationship difficulties, and view situations as more stressful (Adler et al., 2000). In addition, people who perceive themselves as lower in status utilize fewer active coping strategies and report less control over daily life than those with higher perceived status (Adler et al., 2000). These findings remain after controlling for objective measures of SES and general negative affect, suggesting that SSS uniquely relates to stress levels.

Individuals who see themselves as lower in social standing are at greater risk for poor health and disability compared to those who see themselves as higher status in society (Adler et al., 2000; Singh-Manoux et al., 2003; Hu et al., 2005). In cross-sectional studies, people with lower perceived status have higher rates of hypertension (Adler et al., 2008), diabetes (Demakakos et al., 2008), central adiposity (Manuck et al., 2010), and depression (Demakakos et al., 2008) than those higher in SSS. As expected, the relationship between SSS and health variables often decreases in magnitude when controlling for objective SES measures, as they share variance (Singh-Manoux et al., 2003). Typically, however, these objective SES covariates do not fully explain the relationship between SSS and health.

Longitudinal data suggests that the relationship between SSS and health is bidirectional. Those with lower self- and nurse-rated health showed decreases in perceived status

over time compared to those with higher health ratings (Nobles et al., 2013). The opposite directional relationship also appears to be true; rating oneself as lower in social status enhances health risks prospectively. For example, lower baseline social status increased risk for adolescent gain in adiposity (Lemeshow et al., 2008), relapse after smoking cessation (Reitzel et al., 2007), and susceptibility to the common cold (Cohen et al., 2008) at follow-up. In light of these results, the relationship between SSS and health appears complex. In addition, the biological mechanisms underlying these associations are poorly understood.

Inflammation is an important part of the body's response to infection or injury. Proinflammatory cytokines, including IL-6 (interleukin-6), activate immune cells and increase immune cell trafficking as needed (Libby, 2007). This process promotes destruction and clearance of pathogens, which is an essential response to acute infection. However, chronically elevated inflammation can be harmful to health. People with higher levels of inflammation have greater prospective risk for all-cause mortality, frailty, and disability compared to those with lower levels of inflammation (Reuben et al., 2002; Krabbe et al., 2004; Cesari et al., 2012). Elevated inflammation is an important risk factor for a variety of age-related diseases, including cardiovascular disease, osteoporosis, periodontal disease, rheumatoid arthritis, Alzheimer's disease, cancer, and Type 2 diabetes (Ershler and Keller, 2000; Maggio et al., 2006). Indeed, heightened levels of inflammation can affect disease onset and prognosis by contributing to processes such as insulin resistance, atherosclerosis, and tumor survival and growth (Coussens and Werb, 2002; Shoelson et al., 2006; Libby, 2007).

Chronic stress accelerates age-related increases in inflammation (Kiecolt-Glaser et al., 2003). Proinflammatory cytokines such as interleukin-6 (IL-6) increase in response to acute stressors, such as academic exams (Marshall et al., 1998), marital conflict (Kiecolt-Glaser et al., 2005), and standardized laboratory tasks (Steptoe et al., 2007). Over time, stress-induced increases in inflammation may contribute to disease processes such as insulin resistance, atherosclerosis (Black, 2003), and increased ambulatory blood pressure (Brydon and Steptoe, 2005). Individuals differ in their inflammatory responses to stressors, and factors that predict these differences can be helpful in describing stress reactivity.

Converging evidence suggests that inflammatory responses to stressful events may be heightened for those experiencing chronic stress or depression (Fagundes et al., 2013b). In an animal model, rats that received prior inescapable tailshocks had higher IL-6 responses to a bacterial immune challenge than those that were not subjected to stress beforehand (Johnson et al., 2002, 2003). Following an influenza vaccine, serum cytokine levels increased more for individuals with higher levels of depressive symptoms

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