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Review

Autonomic nervous system activity and workplace stressors—A systematic review

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ABSTRACT

Aim: This systematic review evaluates and summarizes the evidence of the association between psychosocial work environment as indicated by several work-stress models such as Job-Demand-Control (JDC), Effort-Reward-Imbalance (ERI), or Organizational Justice (OJ) and autonomic nervous system (ANS) function as indexed by heart rate variability (HRV).
Method: We conducted a systematic literature search following the PRISMA-Statement in eleven databases including Medline, Web of Science and PsycINFO to address medical as well as psychological aspects of the relation between psychosocial work-stress models and HRV.
Results: We identified 19 publications with a total of 8382 employees from ten countries reporting data from the years 1976–2008.

Overall, nine of all studies report a negative and significant association between vagally-mediated HRV and measures of stress at work, while eight of all studies report a negative and significant association to mixed sympathetic and parasympathetic measures of HRV.
Conclusions: This systematic review provides evidence that adverse psychosocial work conditions are negatively associated with ANS function as indexed by HRV.

Contents

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1. Introduction

Metabolic Syndrome (MetS) and cardiovascular diseases (CVD) including essential hypertension are major causes of morbidity and mortality globally for men and women across all age groups (Institute for Health Metrics and Evaluation, 2012; Lim et al., 2012; Lozano et al., 2012). A number of factors have been associated with the development of these conditions, including stress. Stress is thought to exert physiological effects on health through multiple mechanisms that include alteration in the autonomic nervous system (ANS). In particular, psychological stress such as stress at work has been associated with the development of CVD (Kivimäki et al., 2002; Thayer et al., 2010), the pathogenesis of essential hypertension (Backé et al., 2012), and the MetS (Tamashiro, 2011).

Although the exact mechanisms underlying the association of stress and end organ diseases is currently unclear (Kivimäki et al., 2006), previous work by Koolhaas et al. conceptualize stress as the term that "*should be restricted to conditions where an environmental demand exceeds the natural regulatory capacity of an organism, in particular situations that include unpredictability and uncontrollability*" (Koolhaas et al., 2011, p. 1296). Here, the authors distinguish between three important aspects: First, the frequency of a stressor, where chronicity is the toxic element. Second the intensity, ranging from relatively safe to life threatening. And third the environmental challenge, meaning the extent of controllability and predictability of environmental demands (Koolhaas et al., 2011).

Stress is encountered during the life course in a number of situations. Psychological stress in the workplace is particularly common and has been the topic of extensive study. Previous research, for example, demonstrates that multiple aspects of the work environment may be perceived as stressful including having little control over one's job, little input into decision-making, or a sense that daily interactions and decisions at work lack fairness (Harter et al., 2002; Duijts et al., 2007).

While these work-related characteristics may affect one's job satisfaction and may lead to reduced productivity (Harter et al., 2002), increased absenteeism and increased worker turnover (Duijts et al., 2007) and may have substantial economic consequences for the employer (Kirsten, 2010), previous work has suggested that psychosocial features of the workplace have the potential to influence workers health as well (Karasek, 1979; Siegrist, 1996a; Elovainio et al., 2006; Herr et al., 2012).

Several conceptual models have been used to demonstrate potential pathways between psychosocial work stress, health and disease. These include those based on the Job-Demand-Control Model (Karasek, 1979), the Effort-Reward-Imbalance Model (Siegrist, 1996a) and the concept of Organizational (In)justice (Elovainio et al., 2006; Herr et al., 2012).

The Job-Demand-Control Model (JDC) suggests, for example, that stress at work exists when high demands (often appearing in the form of time pressure or work load) and low control (often in combination with monotony) also labeled decision latitude (Karasek, 1979) are present. The model distinguishes four different kinds of stress exposures: high demands, high control (active jobs), low demands, low control (passive jobs), low demands, high control (low strain jobs) and high demands, low control (high strain jobs). Later, the additional aspect of social support extended the model. Here, socially isolated jobs, with high demands and low control put the most strain on people (Karasek et al., 1998).

The Effort-Reward-Imbalance model (ERI) is based on social reciprocity, a core principle element of social action. Applied to the work context, people trade their labor for payment, appraisal and career advancement. According to the model, stress at work exists if an imbalance appears in work input (the effort scale) on the one hand and gratification on the other hand (the reward scale), that is when reciprocity is violated, indicated by a ratio larger than one (Siegrist, 1996b). In addition, this model was also extended by taking work-related commitment and a high need for approval into account (Siegrist et al., 2004). Here, high effort and low reward puts the most stress at work on people.

The model of Organizational Justice (OJ) operationalizes a different dimension of stress at work: the perception of being treated fairly in the workplace (Moorman, 1991). In a meta analysis, four components were revealed: the distributive, procedural, interpersonal, and informational justice components (Colquitt et al., 2001). However, two components explain most of the variance in many investigations (Herr et al., 2012). The procedural component indicates whether decision-making procedures have included input from affected parties, have suppressed bias, and are accurate, correctable, ethical, and applied consistently. The relational component, also labeled as interactional justice, refers to polite and considerate treatment of individuals by supervisors (Elovainio et al., 2006). Here, unequal treatment or inconsistently applied rules, and impolite, disrespectful management put the most distress on people.

In addition to this theory-based operationalization of stress at work, a large number of studies assess workplace stress according to the definition of the three above-mentioned aspects of stress, e.g. the perceived stress scale (Cohen et al., 1983), or the job stress questionnaire (Tabanelli et al., 2008). This usually includes stress-related items such as having to work overtime, being subject to time pressure, having interpersonal conflicts and so on.

The vagus nerve has been known for some time to play a significant role in health and disease (Darwin, 1872; Porges, 2007). Decreased cardiac vagal tone, as indexed by heart rate variability (HRV) has been previously reported to be associated with stress at work in employees (Chandola et al., 2010). The analysis of HRV has been shown to be a reliable, noninvasive measure of the neural control of the heart (Thayer et al., 2012). It has been consistently shown that measures of vagally-mediated HRV have independent associations with mortality and morbidity (Porges, 2007; Thayer et al., 2010). We and others have shown that measures of vagally mediated HRV are for example independently associated with e.g. inflammatory and MetS biomarkers (Jarczok et al., 2013; Thayer and Fischer, 2009).

In this systematic review we attempt to summarize the evidence of an association between psychosocial work environment and HRV in employees. Importantly, we discuss evidence that stress at work that decreases vagally-mediated HRV is associated with increased risk of disease and worsened health profiles.