SHORT COMMUNICATION

Analysis of heart rate variability in natural conditions. The role of anxiety and allergy

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Introduction

Stress can be generally defined as state in which homeostasis is actually threatened or perceived to be so. Organism then reestablishes homeostasis by a complex repertoire of behavioral and physiological adaptive responses (Chrousos 2009). Physiological systems with principal role in stress reaction are HPA axis and autonomic nervous system (ANS). Neuroendocrine research of stress in context of personality variables (Ježová *et al* 2004), found lowered levels of salivary cortisol during psychosocial stress paradigm. Authors interpreted their results in the context of homeodynamic models, as an inability of highly anxious people to answer adaptively to stressful stimuli. Duncko *et al* (2006), reported the discrepancy between subjectively experienced stress and the extent of physiological response. Lowered levels of cortisol were found also in people with allergy (Buske-Kirschbaum *et al* 2010), who were also associated with associated with psychological traits as high anxiety, depression and emotional lability (Hashizume & Takigawa 2006).

If there is a dysregulation in stress reaction on the level of HPA axis, are there similar changes in responses of autonomic nervous system? Following the outlined studies, we examine the changes in both stress systems in relation to allergy and anxiety. We use heart rate (HR) and heart rate variability (HRV), as important physiological biomarkers of ANS activity. In the current research, anxiety mostly amounts to diminished HRV and increased HR, however many studies did not find any significant HR or HRV differences related to anxiety (Dishman *et al* 2000). Recent findings in allergy subjects (Boettger *et al* 2009) support the observation of elevated HRV in allergy. This result is interpreted as a regulatory anti-inflammatory mechanism of the vagus nerve, in reaction to allergic inflammation.

This paper addresses the relationship between allergy, anxiety and heart rate variability (HRV) in naturalistic setting. In continuation to previous laboratory studies, we tried to repeatedly measure HRV and subjective experience of stress, in everyday life of our research subjects. This study is a part of a larger research design, and will report the first findings from four research days carried out between November 2014 and November 2015.

Methods

73 subjects with mean age 22.3 years, standard deviation 3.1 years, most of which were students of Faculty of Arts, Comenius University took part in this study. Subjects were assigned to research groups based on factors of allergy (diagnosed by an allergologist) and trait anxiety (based on inventory STAI. Low trait anxiety score <39, high trait anxiety score >49), as follows: group1: allergic symptoms, low trait anxiety (n=20), group 2: no allergy in anamnesis, high trait anxiety (n=20)., group 3: control group, no allergy in anamnesis, low trait anxiety (n=22). Other 9 subjects with allergy and high trait anxiety were excluded from analysis as well as other 2 subjects due to missing data. This paper further analyses the remaining 62 research

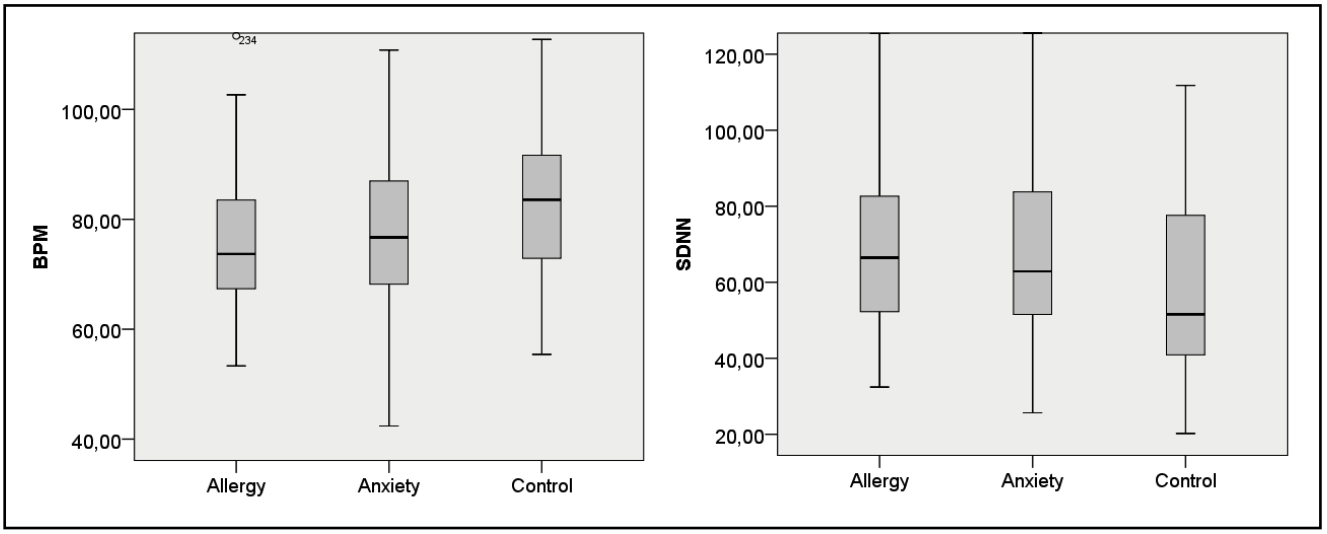

Fig. 1. Differences in mean HR and mean SDNN (HRV) related to allergy and anxiety. Box represents 25–75 percentile.

subjects (28 men, 34 women). During one year, participating subjects took repeated measurements of ECG (later analyzed for HRV), addressed their subjective experiences of stress, and collected saliva samples (for neuroendocrine analysis). ECG was measured by portable device using two electrodes. Used portable ECG devices were constructed in the Institute of electronics and photonics, Slovak technical University. We analyzed 5 min. long ECG samples for HRV in LabChart 8.0 using time-domain and spectral analysis based on FFT algorithm. Subjective experience of stress was addressed using scales related to emotional states, in this paper we refer mostly to 10-point scale of perceived stress and 10-point scale of current mood.

Results

Factors of anxiety and allergy were examined using linear regression controlled for gender and body position during measurement. We found significant differences in heart rate (expressed by beats per minute – BPM) F=4.15, p=0.02, η^2=0.05, and overall HRV (SDNN) F=4.81, p=0.01, η^2=0.06, showing diminished HR and increased HRV in both allergic and highly anxious subjects. Differences in mean HR and HRV are shown in Figure 1.

HRV measures of respiratory sinus arrhythmia (RMSSD, HF-HRV) were also elevated in both allergy and high anxiety group, however these differences were not statistically significant (RMSSD: F=2.82, p=0.06, η^2=0.03, HF-HRV: F=1.94, p=0.15, η^2=0.02).

Furthermore, we found no statistically significant correlation between HRV indices and subjective stress experience, or current mood rated on ten-point scale during the time of measurement.

Discussion

Though we worked with only preliminary data from 4 research days of 62 subjects, our findings of diminished HR and increased HRV in both allergy and high anxiety subjects correspond to previous neuroendocrine findings (Ježová *et al* 2004) of blunted stress reaction in these groups. Though there are not many studies of HRV in allergy, our results are consistent with reported HRV increases (Boettger *et al* 2009). Used naturalistic design results in certain flaws, for example it makes it harder to assess the stressfulness of everyday situations and their impact on physiological reaction in everyday life. There are also limitations in HRV interpretation due to variable conditions during ECG measurement, and also due to interfering factors. We however tried to limit these factors as much as possible during data acquisition and analysis. The chosen naturalistic design helps us to understand better the psychophysiological reaction to normal, everyday stress, and compare findings to laboratory studies. In the follow up to this paper, we will further address HRV changes between stressful and relaxing days, we will further analyze HRV from the perspective of non-linear indices and address the findings from neuroendocrine analyses.

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