

Autonomic Nervous System and CTRA Gene Expression among Healthy Young Adults in Japan

Authors : Yoshino Murakami, Takeshi Hashimoto, Steve Cole

Abstract : The autonomic nervous system (ANS), particularly the sympathetic (SNS) and parasympathetic (PNS) branches, plays a vital role in modulating immune function and physiological homeostasis. In recent years, the Conserved Transcriptional Response to Adversity (CTRA) has emerged as a key marker of the body's response to chronic stress. This gene expression profile is characterized by SNS-mediated upregulation of pro-inflammatory genes (such as IL1B and TNF) and downregulation of antiviral response genes (e.g., IFI and MX families). CTRA has been observed in individuals exposed to prolonged stressors like loneliness, social isolation, and bereavement. Some research suggests that PNS activity, as indicated by heart rate variability (HRV), may help counteract the CTRA. However, previous PNS-CTRA studies have focused on Western populations, raising questions about the generalizability of these findings across different cultural and ethnic backgrounds. This study aimed to examine the relationship between HRV and CTRA gene expression in young, healthy adults in Japan. We hypothesized that HRV would be inversely related to CTRA gene expression, similar to patterns observed in previous Western studies. A total of 49 participants aged 20 to 39 were recruited, and after data exclusions, 26 participants' HRV and CTRA data were analyzed. HRV was measured using an electrocardiogram (ECG), and two time-domain indices were utilized: the root mean square of successive differences (RMSSD) and the standard deviation of NN intervals (SDNN). Blood samples were collected for gene expression analysis, focusing on a standard set of 47 CTRA indicator gene transcripts. The findings revealed a significant inverse relationship between HRV and CTRA gene expression, with higher HRV correlating with reduced pro-inflammatory gene activity and increased antiviral response. These results are consistent with findings from Western populations and demonstrate that the relationship between ANS function and immune response generalizes to an East Asian population. The study highlights the importance of HRV as a biomarker for psychophysiological health, reflecting the body's ability to buffer stress and maintain immune balance. These findings have implications for understanding how physiological systems interact across different cultures and ethnicities. Given the influence of chronic stress in promoting inflammation and disease risk, interventions aimed at improving HRV, such as mindfulness-based practices or physical exercise, could provide significant health benefits. Future research should focus on larger sample sizes and experimental interventions to better understand the causal pathways linking HRV to CTRA gene expression, and determine whether improving HRV may help mitigate the harmful effects of stress on health by reducing inflammation.

Keywords : autonomic nervous activity, neuroendocrine system, inflammation, Japan

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