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Effect of Stress Factors of Stress Response Inventory on Cardiovascular Autonomic Function

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Abstract

Introduction- Stress involves alteration in behavior, autonomic function and the secretion of several hormones such as cortisol, corticosterone, and adrenal catecholamines[1]. **Material and Method-** SRI questionnaire,ECG machine,glucometer,sphygmomanometer, **Results and conclusion-** blood pressures, blood glucose level, mean RR, and SI were positively correlated, whereas body temperature, mean HR, HRV Index, LF, and HF were inversely correlated with ages (Pearson's correlation, $p < 0.05$). All stress factors scores were negatively correlated with ages ($p < 0.001$). In the present study, age was newly found to be correlated with geometrical features such as HRV index, and SI at moderate levels (-0.398 ~ 0.421). In addition, all physiological measures were found to be dependent on ages although at low levels in our subjects (0.244~0.392). Normalized HRV features such as LF/HF.

Keywords- *Heart rate variability; autonomic nervous system; physiological measure; stress; Stress Response Inventory*

Introduction

Stress involves alteration in behavior, autonomic function and the secretion of several hormones such as cortisol, corticosterone, and adrenal catecholamines[1]. Higher blood pressure and heart rates during stress reflected the predominance of sympathetic nervous system activity[2]. Mental stress decreased high frequency of heart rate variability (HRV) and increased low frequency of HRV [3]. HRV decreased in subjects with depression, higher hostility and anxiety[4]. Stress increases susceptibility to negative health outcomes [5]. Numerous stress questionnaires have been used in clinical practice and psychiatric researches such as Perceived Stress Scale (PSS) [6,7], and Stress Response Inventory (SRI) [8]. PSS measures thedegree to which situations in one's life are considered as stressful. SRI scores could be categorized into seven stress factors: tension, aggression, somatization, anger, depression, fatigue, and frustration[8]. Both PSS and SRI were designed to measure stress severity in adults. PSS was designed to assess how unpredictable, uncontrollable, and overloaded respondents find their lives. Unlike PSS, SRI assesses the stress severity based on the stress symptoms or the effects of stressors. In this study, we compared physiological and HRV features in subjects with high and low stress factors to investigate stress-related symptoms and their influence on HRV features.

Materials and Method

The experiment was carried out in Department of physiology,MNR Medical College & Hospital, SANGAREDDY.

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TABLE I.	Ages and genders of participants		
Age	Gender		Total
	Male	Female	
20-29	72	33	105
30-39	43	80	123
40-49	45	45	90
50-69	22	20	42
Total	182	178	360

Subjects who had psychopathic treatment history were excluded from the experiment. 360 subjects participated in studytable(I).

A simplified version of original SRI questionnaire was devised by one of the authors (JMW) and used in this study. The simplified version of SRI questionnaire was composed of 22 questions (Table II) that have been categorized into seven stress factors as in the original SRI [8]. Each question was scored in a five-point Likert scale format: 'Not at all' (0), 'Somewhat' (1), 'Moderately' (2), 'Very much' (3), or 'Absolutely' (4). SRI questionnaires were filled up before the physiological and heartbeat measurements.

Height, body fat, body temperature (at the forehead), blood pressure and blood glucose levels were measured by sphygmomanometer,glucometer.Subjects were seated in the comfortable chair and rested for five minutes prior to the heartbeat measurement. Three minute records of heartbeat were then recorded right after the resting stage. ECG was used to produce heartbeat (R peak) interval records.

TABLE II	A simplified stress response inventory items
CATEGORIZED INTO SEVEN STRESS FACTORS	
Stress Factor	Questions
Tension	My body trembles.
	I feel tense.
	My head hurts or it feels heavy.
Aggression	I act violently (such as reckless driving, cursing, fighting).
Somatization	I suffer from indigestion.
	My stomach hurts.
	I feel dizzy.
Anger	My voice is louder than it usually is.
	I easily get impatient.
Depression	I often stare blankly.
	I feel bored.
	I am useless (or unworthy).
	I don't like moving any part of my body.
Fatigue	I am easily fatigued.
	I feel totally exhausted.
Frustration	Everything bothers me.
	I feel on edge.
	My heart throbs.

To assess the association with stress factors, individual SRI scores were grouped into their corresponding stress factors (Table II) to calculate stress factor scores. Dependence on ages of stress factor scores as well as physiological measures and HRV features was evaluated using Pearson's correlation analysis. Dependence on stress factors of physiological measures and HRV features was evaluated using multiple regression analysis.

The subjects were divided into low and high stress group using k-means cluster analysis.Physiological measures and HRV features in these two groups were compared, with age as the covariate using analysis of covariance (ANCOVA).

Results

Relationships of Physiological Measures, HRV Features, and Stress Factors with Ages

Table III summarizes the relationships of physiological measures, HRV features, and stress factors with ages. Body fat content, blood pressures, blood glucose level, mean RR, and SI were positively correlated, whereas body temperature, mean HR, HRV Index, LF, and HF were inversely correlated with ages (Pearson's correlation, $p < 0.05$). All stress factors scores were negatively correlated with ages ($p < 0.001$).

Tension, depression and frustration were the stress factors that were frequently associated with body fat, body temperature, and HRV features. Depression factors were positively associated with body fat, body temperature, SI, and HFnu; negatively associated with LF, LF/HF, and LFnu (multiple regression, $p < 0.05$). Tension factors were positively associated with LF, LF/HF, and LFnu; negatively associated with body fat and HFnu (multiple regression, $p < 0.05$). Frustration factors were positively associated with SI, LF/HF, and LFnu; negatively associated with, HRV Index, HF and HFnu.

Cluster analysis classified 225 subjects as low stress factor (total SRI scores: 7.1 ± 4.1) and 135 as high stress factor group (22.5 ± 7.4).

Using ANCOVA with age as covariate, several physiological measures and HRV features were found to be significantly different in the low and high stress factor group (Table IV). Systolic blood pressure, glucose level, and HFnu were significantly lower, whereas body temperature, LF/HF, and LFnu were significantly higher in high stress factor group.

Conclusions and Discussion

Previous studies have found that HRV declines with ages [11, 12]. In the present study, age was newly found to be correlated with geometrical features such as HRV index, TINN, and SI at moderate levels (-0.398 ~ 0.421) (Table III). In addition, all physiological measures were found to be dependent on ages although at low levels in our subjects (0.244~0.392). Normalized HRV features such as LF/HF,LFnu, and HFnu did not show significant dependence on ages (Table III).

TABLE III.	**Statistically significant features that Distinguish two groups with low versus high stress factors (Ancova with age as covariate, P<0.05)**	
Measures	**Subject with Low Stress Factor Scores (n=225)**	**Subjects with High Stress Factor Scores (n=135)**
Body Temperature	36.36 ± 0.352	36.43 ± 0.629
Systolic blood pressure	120.0 ± 14.12	115.5 ± 13.39
Glucose level	98.38 ± 17.20	91.70 ± 12.10
LF/HFSTRESS factors	1.751 ± 1.715	1.862 ± 1.526
LFnu	53.43 ± 18.74	56.94 ± 16.94
HFnu	45.82 ± 18.93	42.31 ± 17.15

TABLE IV	**Relationships of physiological measures, HRV features, and stress factors with ages (Simple regression, N=360)**
Measurements/Stress Factors	**Correlation with age (r)**
Body fat	0.255**
Body temperature	-0.304**
Systolic blood pressure	0.322**
Diastolic blood pressure	0.244**
Glucose level	0.392**
Mean HR	-0.138*
Mean RR	0.139*
HRV Index	-0.402**
SI	0.421**
VLF	-0.233**

Cont... **TABLE IV**

LF	-0.270**
HF	-0.155**
LF/HF	-0.023
LFnu	-0.069
HFnu	0.063
Tension	-0.236**
Aggression	-0.234**
Somatization	-0.190**
Anger	-0.232**
Depression	-0.259**
Fatigue	-0.245**
Frustration	-0.246**

*p < 0.05

Physiological measures and HRV features were correlated with the stress factor scores in the SRI questionnaire (data not shown). In brief, tension, depression and frustration were the main stress factors associated with HRV features. Tension and frustration factors were positively associated with the sympathetic activity (LF and LFnu) and negatively associated with parasympathetic activity (HFnu). Conversely, depression factors were negatively associated with sympathetic activity and positively with parasympathetic activity. During the experience of negative emotions such as anger, frustration, or anxiety, heart rhythms are known to become disordered, indicating less synchronization in the reciprocal action between the parasympathetic and sympathetic branches of the ANS [13].

Since age was a strong factor influencing HRV features, we sought to rule out age-dependent features and seek out the relationship between stress factors and HRV features. Cluster analysis using stress factor scores was useful to identify high stress group in our case. High stress group showed higher LF/HF (reflects the predominance of sympathetic over parasympathetic activity) and LFnu (mainly influenced by sympathetic activity), whereas lower HFnu (mainly influenced by parasympathetic activity) compared to the low stress factors group (Table IV). Significant association of stress factors with HRV features suggested that the questionnaire items in our simplified version of SRI are useful to classify subjects into high and low stress group. In addition, our results indicated that further investigation is warranted for stress factors and their relationships with body temperature systolic blood pressure, and blood glucose level.

Conflict of Interest – Nil

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Ethical Clearance – Given by the Institution.

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