Comparison of Heart Rate Variability during Physical and Mental Stress in Type 'A' and Type 'B' personality: An Interventional Study

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Abstract*—Stress is the gift of today's modernization. It may influence autonomic nervous system (ANS). It may reflect on Heart Rate Variability (HRV). Personality may affect the stress level effect on ANS. So this comparative interventional study was conducted to compare HRV response of physical and mental stress in both type of personality (type 'A' and type 'B'). This study was conducted of 30 type 'A' personality and 30 type 'B' personality subjects. Baseline HRV was recorded then mental stress is given and HRV was again recorded after 5 minutes. After 5 minutes physical stress was given and HRV was again recorded after 5 minutes. Mean change in HRV was compared in both the personality after mental and physical stress. Significance of this mean difference was ascertain with the help of unpaired 't' test. It was found that In Physical stress, all the parameters of HRV are significantly reduces in type 'A' personality than type 'B' personality except parasympathetic activity which was significantly less in type 'B' personality than type 'A'. In mental stress, there was no significant difference in all the parameters of HRV in type 'A' personality than type 'B' personality except in heart rate which was significantly reduced in type 'B' personality than type 'A'. The present study concluded that the mental stress should be avoided by both personality subjects, as it increases the sympathetic and reduces the parasympathetic outflow. Physical stress is beneficial to type 'A' personality subjects.*

Keywords: Heart Rate Variability (HRV), Autonomic Nervous System (ANS),Type of personality, Mental Stress, Physical Stress.

I. INTRODUCTION

Stress is the body's response to counteract the challenges that influences our autonomic nervous system (ANS). The ANS consist of sympathetic and parasympathetic nervous system and their activity are reflected by heart rate variability (HRV). Fluctuations in heart rate above 0.03 Hz reflect autonomic modulation of sinoatrial node activity. The low frequency (LH: 0.03-0.15Hz) and high frequency (HF: 0.15-0.80Hz) power represent sympathetic and parasympathetic nervous system activity respectively and LF: HF ratio has been used to quantify the sympathovagal balance.[1] A link between work stress and disease related to the sympathetic and parasympathetic system. HRV analysis provide state of body and mind, the LH, HF and LF: HF ratio adopted as a marker of stress in various studies[1,2,3] Research indicate that type of personality also influences the subjective response to stress. Coronary heart disease is more common in individuals subjected to chronic stress. The Type 'A' personalities are more prone to coronary disease, more risk for heart attacks, while Type 'B' personality has lower stress levels.[4]

The previous studies focus on either physical or mental stress only, the relation is not established between HRV and mental and physical stress of an individual of different personalities. Among normal subjects, males are under the dominance of sympathetic system whereas females reveal parasympathetic

preponderance. Cardiac autonomic modulations as determined by HRV are significantly lower in healthy women as compared to healthy men. So in this study, the only males are taken as subjects.

This present study approach to compare the effect of physical and mental stress in both personality subjects (A & B) in terms of sympathetic (LH) and parasympathetic (HF) component of HRV and also quantify the sympathovagal balance (LF: HF ratio). The present study is designed to observe, is there any relation of HRV with the type of personality during physical and mental stress.

II. METHODOLOGY

This present study is comparative interventional study, conducted in Department of Physiology after approval of Institutional Ethical committee and after taking consent from participants.

The all male participants of age group 18 to 30 years were taken, from ministerial staff of SMS Medical College, Jaipur. The participants were divided into two groups based on their personality by applying Glaze Questionnaire[5]. Glaze Stress control lifestyle questionnaire have 20 questions, each have 2 polar end and have 1 to 7 score. Each participant had chosen the relevant score and after that total score was calculated and then personality was separated accordingly.

Type ‘A’ personality having 80 to 140 total scores

Type 'AB' personality 60-79 total scores

Type ‘B’ personality <59 total scores

Type 'AB' personality was excluded from the study.

Procedure: The total 60 participants, out of whom 30 were taken from each personality (Type ‘A’ & Type ‘B’) for study purpose. The whole procedure were explanted to participants and instruction were given to participants to avoid eating 2 hour prior to recording of test, and the coffee, nicotine, alcohol should not to be taken before 24 hour. And they were also advised to wear loose and comfortable clothing during test recording. The baseline Heart Rate Variability (HRV) was taken for short term analysis. After giving 15 minute rest to all participants, the HRV was recorded for 5 minutes, at ambient room temperature 24-25^0 C. The participants were subjected to mental and physical stress. The mental stress was applied by asking subjects to subtract 13 starting with 3000 in reverse direction. The HRV was recorded during mental stress for 5 minutes. After giving 5 minutes rest to subject the physical stress was applied by asking the subject to 45- degree shoulder adduction of one arm with maximum extension and arm also remain unsupported by any other object. The HRV was also taking during physical stress for 5 minutes. The HRV recording was done by CANWin Window based Cardiac Neuropathy Analysis System (version 1.0)

Statistical Analysis: The data was presented in mean and SD. The mean change by physical stress and mental stress was calculated by subtracting baseline HRV variables from HRV variables during stress (physical and mental). They were further analysed by student unpaired ‘t’ test to compare the mental and physical stress in Type ‘A’ and Type ‘B’ personalities by using primer (version 6). The P value <0.05 is considered as statistically significant.

III. RESULTS

The present study observed that In Type ‘A’ personality subjects during physical stress, the heart rate, LF & LF: HF ratio (sympathetic component) were decreased while the HF (parasympathetic

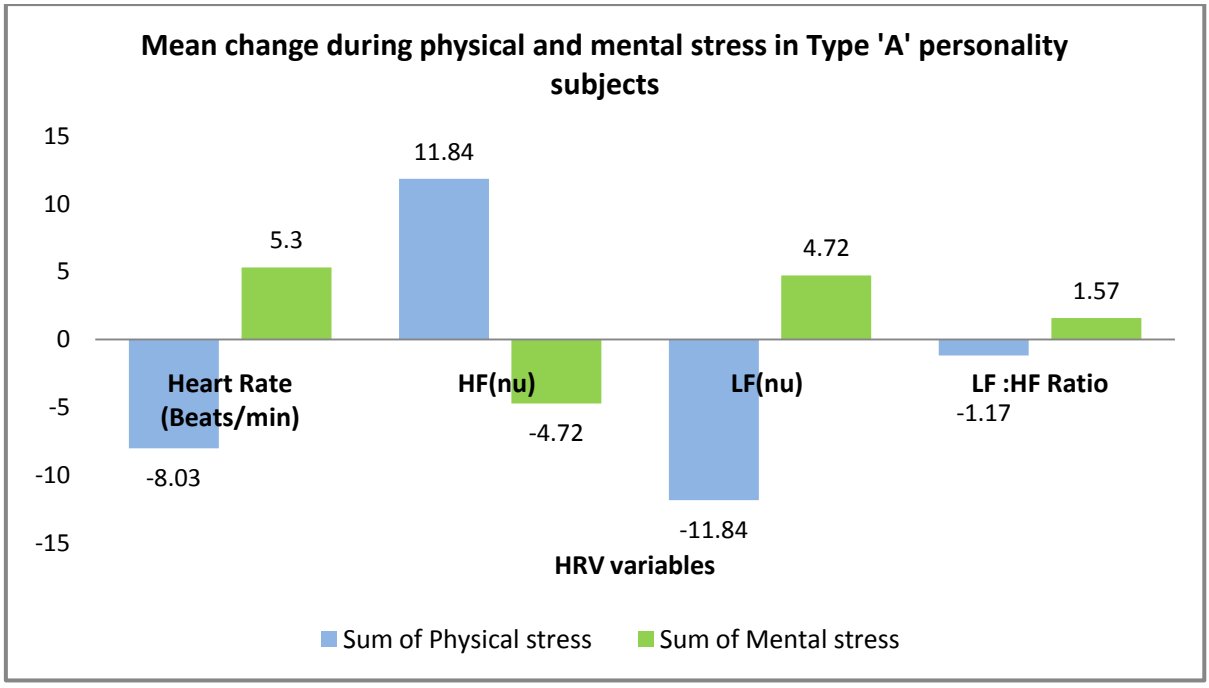
component) was increased. Whereas during mental stress, the heart rate, LF & LF: HF ratio (sympathetic component) increased, though the HF (parasympathetic component) decreased during mental stress. (Table 1& Figure 1)

Table 1
Comparison of HRV variables during physical stress and mental stress in Type 'A' Personality subjects (N=30)

S. No	HRV Variables	Baseline Mean ± SD	Physical stress Mean ± SD (mean change)	Mental stress Mean ± SD (mean change)	Significance
1	**Heart Rate (Beats/minute)**	84.77± 0.90	76.74 ± 3.36 (-8.03 ±3.28)	90.07 ± 1.91 (5.30 ±2.01)	p<0.001*
2	**LF(nu) Symapthetic**	72.94 ± 3.82	61.10 ± 3.94 (-11.84 ±5.32)	77.66 ± 8.04 (4.72 ±8.82)	p<0.001*
3	**HF(nu) Parasymapthetic**	27.06 ± 3.82	38.90 ±3.94 (11.84± 5.32)	22.34 ± 8.04 (-4.72± 8.82)	p<0.001*
4	**LF:HF Ratio (Sympathovagal balance balance)**	2.77 ± 0.54	1.60 ± 0.27 (-1.17 ± 0.58)	4.33 ± 2.80 (1.57 ± 2.81)	p<0.001*

Significant

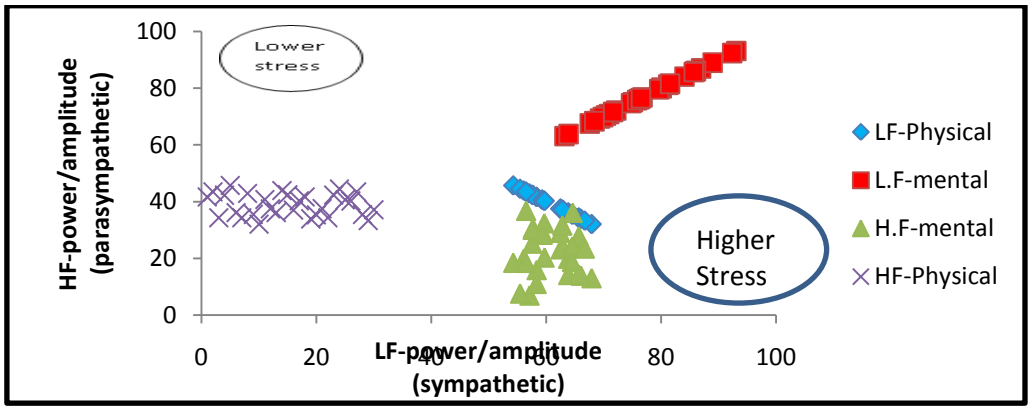
Figure 1



Symapthovagal balance observed by LF:HF ratio is better explained by 2Dscatter diagrams. The physical exercise reduces the stress while mental stress in between showing symapthovagal balance. (Figure 2)

Figure 2

Scatter Diagramme of HRV in Type 'A' Personality



In Type 'B' personality there was significant rise in heart rate during physical stress than mental stress. While, there was no significant change in sympathetic and parasympathetic component of ANS during physical and mental stress. (Table 2 & Figure 3)

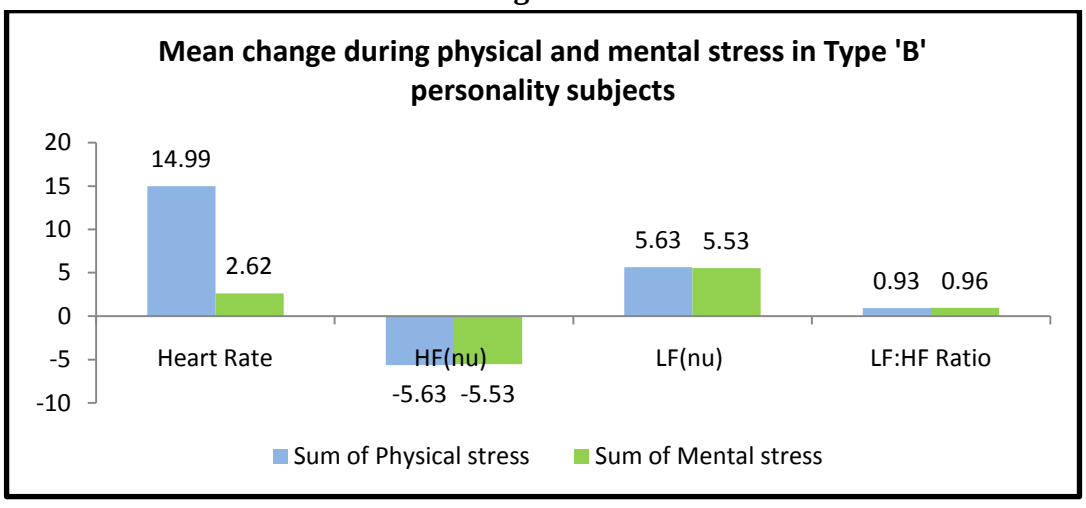
Table 2

Comparison of HRV variables during physical stress and mental stress in Type 'B' Personality (N=30)

S. No.	HRV Variables	Baseline **Mean** ± SD	Physical stress **Mean** ± SD (mean change)	Mental stress **Mean** ± SD (mean change)	Significance
1	**Heart Rate (Beats/minute)**	77.04 ±1.18	92.03± 1.00 (14.99 ±1.28)	79.66± 3.24 (2.62 ±3.45)	p<0.001*
2	**LF(nu) Symapthetic**	68.9 ± 3.38	74.5 ±6.33 (5.63 ± 8.28)	74.4 ±6.81 (5.53 ± 8.14)	P=0.953
3	**HF(nu) Parasymapthetic**	31.11 ± 3.38	25.5 ± 6.33 (-5.63 ± 8.28)	25.6 ± 6.81 (-5.53 ± 8.14)	P=0.953
4	**LF:HF Ratio (Sympathovagal balance balance)**	2.25 ± 0.36	3.18 ± 1.11 (0.93 ± 1.29)	3.21 ± 1.21 (0.96 ± 1.31)	P= 0.921

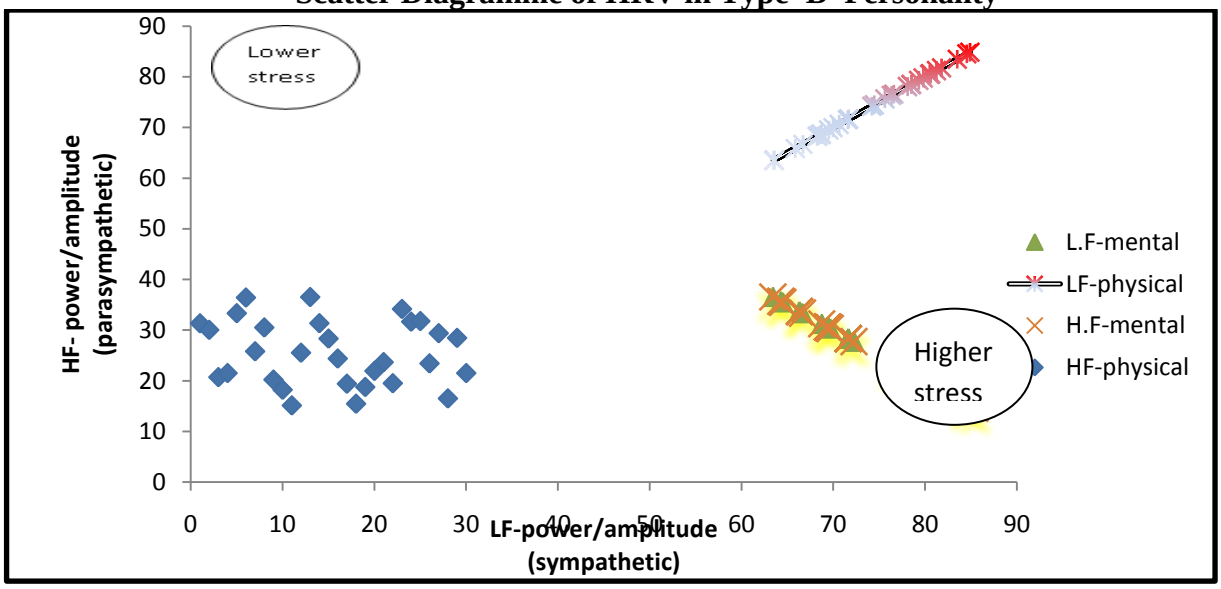
Significant

Figure 3



Symapthovagal balance observed by LF:HF ratio is better explained by 2Dscatter diagrams (Figure 4)

Figure 4
Scatter Diagramme of HRV in Type 'B' Personality



In physical stress, all the parameters of HRV are significantly reduces in type 'A' personality than type 'B' personality except parasympathetic activity which was significantly less in type 'B' personality than type 'A'. (Table 3)

Table 3
Comparison of mean change in HRV variables during physical stress in Type 'A' and Type 'B' Personality subjects

S. No	HRV Variables	Type 'A' (Mean ± SD) (N=30)	Type 'B' (Mean ± SD) (N=30)	Significance
1	Heart Rate (Beats/minute)	-8.03 ±3.28	14.99 ±1.28	p<0.001*
2	LF(nu) Symapthetic	-11.84 ±5.32	5.63 ± 8.28	p<0.001*
3	HF(nu) Parasymapthetic	11.84± 5.32	-5.63 ± 8.28	p<0.001*
4	LF:HF Ratio (Sympathovagal balance balance)	-1.17 ± 0.58	0.93 ± 1.29	p<0.001*

Significant

In mental stress, there was no significant difference in all the parameters of HRV in type 'A' personality than type 'B' personality except in heart rate which was significantly reduced in type 'B' personality than type 'A'. (Table 4)

Table 4
Comparison of mean change in HRV variables during mental stress in Type 'A' and Type 'B' Personality subjects

S. No	HRV Variables	Type 'A' (Mean ± SD) (N=30)	Type 'B' (Mean ± SD) (N=30)	Significance
1	**Heart Rate (Beats/minute)**	5.30 ±2.01	2.62 ±3.45	p<0.001*
2	**LF(nu) Symapthetic**	4.72 ±8.82	5.53 ± 8.14	P=0.713
3	**HF(nu) Parasymapthetic**	-4.72± 8.82	-5.53 ± 8.14	P=0.713
4	**LF:HF Ratio (Sympathovagal balance balance)**	1.57 ± 2.81	0.96 ± 1.31	P=0.286

Significant

IV. DISCUSSION

In the present study the Type 'A' personality subjects showed a decrease in the sympathetic component of HRV (LF) while parasympathetic component of HRV (HF) increased during physical stress and also sympathovagal balance (LF: HF ratio) favours the parasympathetic dominance. Whereas during mental stress sympathetic component increased in Type 'A' personality subjects. In Type 'B' personality subjects physical stress more stimulate the heart rate than mental stress, other parameters shows a statistically non-significant effect between mental and physical stress in Type 'A' personality.

The present study found the physical stress is beneficial for Type 'A' personality subjects, whereas in Type 'B' personality both type of stress stimulate sympathetic, while physical stress increases the heart rate more.

The present study HRV parameters were influenced by stress (both physical and mental stress) similar to Simiran Kaur et al[6] with non-significant difference, except heart rate that is raised significantly very high by physicals stress than mental stress in Type 'B' personality subjects. Whereas in Type 'A' personality sympathetic increased and parasympathetic component of HRV decreased by mental stress similar to Simiran Kaur et al [6] studies.

In contrast to Simiran kaur et al[6] our findings shows a decrease in sympathetic (LF & LF: HF ratio) and increase in parasympathetic component (HF) with statistically high significant difference in Type 'A' personality subjects during physical stress. It is well documented in various studies that, the physical exercise immediately rise the sympathetic, but in long term rise the parasympathetic's and also beneficial of all personality subjects. Physical stress elevates parasympathetic and reduces sympathetic for Type 'A' personality subjects, as parasympathetic is for energy conservation and for vegetative growth, brings an individual to its resting state.

Arai et al. (1989) found a decreased in LF power during increased exercise level.[7] Similarly Billman (2013a)[8] and Sacha (2014)[9], in an attempt to explain influence of the heart rate on HRV, the low LF values were observed during physical exercise. Whereas in present study the low LF (sympathetic) with high significance difference was observed during physical exercise only in Type 'A' personality subjects.

Punita et al[10] found all the frequency domain indices were reduced with increase intensity of mental stress in medical students, except for LF which significantly increased. Michels et al[11] found low HRV (lower parasympathetic activity) might serve as stress indicator in children. Clays et al.[12] perform 24 hr continuous HRV recording on 653 male (40–55yrs), those selected on Job Stress Questionnaire (JSQ) .The work stressor index was significantly associated with lower HF power and a higher ratio of LF/HF power. Similarly in our study the sympathetic component (LF, LF:HF ratio) increased and parasympathetic component (HF) deceased during mental stress in both type A and Type 'B' personality subjects.

Neurobiological evidence of HRV as a stress measurement: Claude Bernarde's (1865) first found that the vagus nerve serves as a structural and functional link between the brain and the heart.[13] Continuous perception of stress is harmful to the human body and affects the regulation of hippocampal circuits, endocrine systems, ANS, and other physiological functions, which are reflected in HRV changes.[14-17] HRV can measure the degree of functional integration of the axes connecting ventromedial prefrontal cortex (VMPFC), brainstem and peripheral anatomy and can represent the degree to which it provides flexible control over ANS. The prefrontal cortex is related to our emotions and brainstem is concern with autonomic regulation of heart rate and peripheral anatomy is associated with distribution of sympathetic & parasympathetic nerves.

Limitations: Symapthovagal balance cannot be quantified by a single assessment of LF and HF, which assume a simplistic linear relationship between the activity of ANS and the frequency bands. The other neurohormonal assessment like cortisol, salivary amylase level should be measured. The other test like sympathetic skin response, biofeedback measurement etc. should be involved in the study. To establish a diagnostic tool to balance the symapthovagal system, the study should be on the large population. The less literature is available regarding physical stress in different personality subjects.

Future research: The HRV measures along with above mentioned test can be used for future research to observe the effect of different grades of exercise in various personality subjects for reducing stress level.

V. CONCLUSION

The present study concluded that the mental stress should be avoided by both personality subjects, as it increases the sympathetic and reduces the parasympathetic outflow. Physical stress is beneficial to type 'A' personality subjects.

CONFLICT OF INTEREST

None declared till now.

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