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Impact of Stress and Personality on Heart Rate Variability (HRV) in Prehypertensives

Mangani Mangalavalli Shanmugarajah[1], Premaraja Ramalingam[2], Senthil Velou Munian[3]

Author Affiliation

[1]Assistant Professor, Dept. of Physiology, Sri Manakula Vinayagar Medical College and Hospital, Madagadipet, Puducherry 605107, India. [2] Assistant Professor, Dept. of Physiology, Sri Lakshmi Narayana Institute of Medical Sciences, Osudu Agaram Village, Villianur Commune, Kudapakkam Post, Puducherry, 605502, India. [3]Assistant Professor, Dept. of Physiology, All India Institute of Medical Sciences, Mangalagiri, Andhra Pradesh 520008, India.

Corresponding Author

R. Premaraja, Assistant professor, Department of Physiology, Sri Lakshmi Narayana Institute of Medical Sciences, Osudu Agaram Village, Villianur Commune, Kudapakkam Post, Puducherry, 605502, India.

E-mail: Premaraja_r@yahoo.com

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Abstract

Stress is an indispensable aspect of our daily life. Individual of Type-A or type-B personalityrespond to the same stressful event differently. Aim of this study was to assess theimpact of stress and personality on Heart Rate Variability (HRV) in prehypertensives. 115 participants were categorized into type-A and type-B personalities based on modified jenkin's questionarie as normotensives and prehypertensives based on their blood pressure recordings. During the mental stress, the TP, HF nu, HF LF were decreased ($p<0.05$). The LF nu and LF/HF ratio were increased ($p<0.05$), which was statistically significant, indicating an increased sympathetic activity and decreased parasympathetic activity in type-A prehypertensives. We can conclude that the effect of mental stress on HRV in type –A prehypertensives was much more than type-B personalities. This proves that type-A prehypertensives have a hyperactive sympathetic system and are more susceptible to stress than type-B individuals.

Keywords: Type-A Personality; Type-B Personality; Prehypertension, Heart Rate Variability; Stress.

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Introduction

Stress is an increasing occupational health problem and a significant cause of economic loss [2]. Stress may cause work related illness either directly or indirectly [3]. Our body tries to communicate with us through these signs which when neglected causes serious health problems like hypertension, cardiac diseases.

Prehypertension is systolic BP from 120 to 139 mmHg or a diastolic BP of 80 to 89 mmHg. Prehypertension is a risk factor for cardio vascular disease, decreasing the life expectancy of an individual by 5 years, as it often develops into hypertension (50% of people in 4 years) [2,4,5,6].

Prevalence of prehypertension in India is around 7% [9] with an increase seen in south India. Prehypertension is often asymptomatic, so all the more care is needed in identifying and treating them with life style modifications and curtailing risk factors like obesity, sedentary life style, high sodium foods, alcohol, smoking, family history and to start drugs if needed [4].

The general healthy population is classified broadly into two main categories on the basis of their response to stress, as type-A and type-B personalities. Type–A being always in a rush, to accomplish more in a less time. Try to do more than 2 or 3 activities at a time and feels guilty for relaxing for a few hours. Whereas type-B personalities believe in the virtue of patience, can relax and do nothing for days without feeling

guilty and maintain a sense of calmness. Hence type-A persons has a hyperactive sympathetic nervous system [10] and are more prone to develop cardiac problems and hypertension. The difference between both the personalities depend only on the fact as to how they respond to a stressful situation in different ways [7].

Heart rate variability is one of the most upcoming and promising tool in assessing the autonomic activity [10,11]. The easy and non-invasiveness of this method has popularized its use [12]. Electrocardiographic RR intervals fluctuate in a cyclic pattern, modulated by ventilation, baroreflexes and other environmental and genetic factors that are mediated through the autonomic nervous system. Short term ECG recording (5-15 minutes) taken in supine or standing positions. RR interval variability is used to assess cardiovascular risk [13]. This study was done to find out the variations in autonomic balance in type-A and type-B personalities with prehypertension. Power spectral analysis of heart rate variability was used to assess the sympathovagal interaction which has not been previously employed in studying type-A and type-B personalities with prehypertension.

Materials and Methods

Study area and setting

The present study was conducted in the of Department of Physiology, Sri Manakula Vinayagar Medical College and Hospital (Smvmch), Pondicherry.

Study design: Cross Sectional Study.

Study Duration

The study was started after approval from the Institutional Ethics Committee and was completed within one year.

Sample Size

Considering the prevalence of prehypertension in India to be 7%, 95% confidence interval, 80% power the minimum sample needed for the study was calculated to be 101 using Epi-info (version 6.04d) software package. Bearing in mind, factors like refusal to consent / non response sample size is taken as 115.

Sampling

On an average 10 subjects, who were accompanying patients to medicine OPD on Wednesdays, were recruited for the study.

Inclusion and Exclusion Criteria

Following were the inclusion and exclusion criteria considered for selection of study participants.

Inclusion criteria

1. Individuals of both genders in the age group of 18-35 years.
2. Relatively healthy individuals without any known diseases that might affect the Autonomic Nervous System, either directly or indirectly.
3. People not on any drugs, which might affect the Autonomic Nervous System.

Exclusion criteria

1. People on any medications or having some diseases which might affect the Autonomic Nervous System.
2. Hypertensives on treatment
3. Unable to cooperate to undergo the study.
4. Borderline personalities (Type-AB)
5. Orthopaedic deformities.

Methodology and data collection

1. Attenders accompanying patients to the medicine OPD, on Wednesdays, were considered for the study.
2. After obtaining informed consent, relevant history was obtained from the participants.
3. Anthropometric measurements like Height, Weight and Waist circumference were measured; and Body mass index was calculated.

a. Height

Height was measured to the nearest 0.1 cm while the subject was standing in erect position withbare feet on flat floor against a vertical scale and with heels touching the wall and head straight [14]

b. Body weight

Body weight was measured while the subject was minimally clothed and without shoes, standing motionless on a weighing scale and it was recorded to the nearest 0.1kg [14]

c. Body Mass Index:

Body Mass Index was calculated using Quetelet Index formula where, weight in kilograms was divided by square of height in meters (kg/m^2) [14].

d. Waist circumference

Waist circumference (centimetres) was measured at a point mid-way between the lower rib and iliac crest [14].

4. Questionnaire

A questionnaire was administered to the selected group to collect the data by my colleague, as a blinding procedure. The personality type-A/B questionnaire is a modified version of the Jenkins Activity Survey (Jenkins Zyzanski & Rosenman, 1971)[15]. The relatively healthy attenders were categorized into type-A and type-B personalities.

5 Blood pressure

Blood pressure was measured by the principal investigator. After giving half an hour rest to the person in the departmental laboratory, blood pressure was measured in supine position by mercury sphygmomanometer, between 10 am to 11 am. Blood pressure was measured three times. The average of second and third readings was taken as correct systolic and diastolic blood pressure. Prehypertensives are diagnosed as per JNC 7 criteria [14,16,17].

6. Every individual was made to rest for 15 minutes before taking a 5 minute baseline ECG bythe primary investigator, in a comfortable room temperature and atmosphere [13]. The datathus collected was digitized and stored for analysis by frequency domain method as elaborated below

Laboratory conditions and BP recording

Subjects were asked to report to autonomic function testing (AFT) laboratory in the department of physiology at Sri Manakula Vinayagar Medical College, at about 10 AM following a light breakfast, without tea or coffee. The temperature of AFT laboratory was maintained at 25^0C for all the recordings. Informed consent was taken from the subjects who satisfied the inclusion criteria. Jenkin's modified personality assessment questionnaire was given to categorize them into type-A or type-B personality depending on their score. Their age, height, body weight and body mass index were recorded. BP of all the subjects was recorded in AFT laboratory. For BP recording, the subject was asked to sit upright keeping one forearm on a wooden table kept in front and close to the subject. General precautions while measuring BP, like, apparatus was kept at the level of the heart, appropriate sized BP cuff was tied just tight (neither too tight nor loose) on the arm approximately 2 cm above the cubital fossa, adequate rest was given before recording the resting BP. For each subject, SBP, DBP and BHR were recorded in each arm twice at an interval of five minutes between the recordings, and for each parameter the mean of the four recordings was considered. (18)

The subjects were made to lie supine and 15 minutes of rest given prior to HRV recording. The short term HRV recording (5 minutes) was done. For recording of HRV, recommendation of the Task Force on HRV was followed.(13)

In order to record HRV, ECG electrodes were connected and Lead II ECG was acquired at a rate of 1000 samples/second at supine resting posture using RMS POLYRITE data acquisition system. Ectopics and artifacts were removed from the recorded ECG. The data was exported for HRV analysis which was done using the KUBIOS software (Kubios analysis group, Finland).

Following frequency domain indices were calculated from the HRV recordings.

A. Frequency domain indices (FDI)

1. Total power (TP)

2. Low frequency power (LF)

3. Normalized LF power (LFnu)

4. High frequency power (HF)

5. Normalized HF power (HFnu)

6. LF-HF ratio

7. Every individual was subjected to both physical and mental stress with 15 minutes rest inbetween both the tests. Mental stress was given by asking the subject to do reverse calculations by subtracting 13 starting from 3000, [19] and physical stress was given by asking them to abduct the shoulder joint by 45degrees, with one arm not supported and with maximum extension [20].

Results

In the table 1, keeping the at rest values as baseline values, the effect of mental stress and physical stress on the frequency domain parameters of HRV were compared. During the mental stress,

the TP, HF nu, HF LF were decreased. The LF nu and LF/HF ratio were increased, indicating an increased sympathetic activity and decreased parasympathetic activity. This difference was more during the mental stress as compared to the physical stress. This clearly demonstrates the fact that the effect of mental stress on HRV in type –A individuals was much more than the physical stress. The results were statistically significant.

In the table 2, keeping the at rest values as baseline values, the effect of mental stress and physical stress on the frequency domain parameters of HRV were compared. During the mental stress, the TP, HF nu, HF LF were decreased. The LF nu and LF/HF ratio were increased, indicating an increased sympathetic activity and decreased parasympathetic activity. This difference was more during the mental stress as compared to the physical stress. This clearly demonstrates the fact that the effect of mental stress on HRV in type –B prehypertensives was much more than the physical stress. The results were statistically significant.

From the table 3, it is obvious that type-A individuals have an increased sympathetic activity as the LF/HF ratio is high. Further the effect of mental stress on HRV is much more in type-A than physical stress. Thereby we can conclude that the type-A individuals have a hyperactive sympathetic system with vagal withdrawal and the effect of mental stress on HRV is much more as compared to the physical stress. The results were statistically significant.

Table 1: :Effect of physical and mental stress on frequency domain parameters in type- a prehyperttensives

Parameters	At Rest	Physical Stress	Mental Stress	p Value
TP	547.85 ± 48.97	584.06 ± 49.27	542.41 ± 57.45	0.001**
LF nu	69.23 ± 6.47	71.79 ± 7.19	74.95 ± 7.14	0.002*
HF nu	39.50 ± 4.62	36.87 ± 4.89	32.69 ± 4.63	0.0001**
LF	325.25 ± 41.97	287.49 ± 43.16	258.78 ± 42.19	0.0001**
HF	178.25 ± 17.32	151.87 ± 17.74	125.87 ± 18.40	0.0001**
LF/HF	1.84 ± 0.27	1.91 ± 0.33	2.09 ± 0.44	0.004*

p value <0.05 was considered statistically significant and p < 0.0001 was highly significant.

Table 2: Effect of phsical and mental stress on frequency domain parameters in type-b prehypertensives

Parameters	At Rest	Physical Stress	Mental Stress	p Value
TP	540.10 ± 55.80	546.19 ± 41.99	497.79 ± 53.66	0.007*
LF nu	69.88 ± 6.76	71.73 ± 7.97	75.04 ± 8.11	0.105
HF nu	39.05 ± 4.07	36.09 ± 4.15	31.88 ± 3.96	0.0001**
LF	294.35 ± 31.17	257.53 ± 32.94	228.81 ± 33.34	0.0001**
HF	182.75 ± 14.91	155.88 ± 13.45	129.94 ± 13.39	0.0001**
LF/HF	1.61 ± 0.16	1.66 ± 0.19	1.77 ± 0.20	0.044*

p value <0.05 was considered statistically significant and p<0.0001 was highly significant.

Table 3: Effect of mental and physical stress on hrv in type-a and type-b individuals with prehypertension.

Personality	Parameters	At Rest	Physical Stress	Mental Stress	P Value
Type-A	LF/HF	1.84 ± 0.27	1.91 ± 0.33	2.09 ± 0.44	0.004*
Type-B	LF/HF	1.61 ± 0.16	1.66 ± 0.19	1.77 ± 0.20	0.044*

p value <0.05 was considered statistically significant.

Discussion

The present study was a hospital based cross sectional study with 115 participants, done to measure and compare the effect of stress on Heart rate variability in type- A and type-B individuals with prehypertension.

In the present study, the prevalence of type-A personality was 56.52% and that of type-B was 43.48%, In contrary , Aliya Hisam et al. [21] in their study of 500 participants,10.8% students were type-A and 89.2% were type- B. In the present study, prevalence of type-A in normotensives was 38.46%, the results were similar to the studies done by Howard et al., and Rosenman RH et al., and Jane Irvine et al. [22-24] in which the prevalence of type-A was 58% and 50% and 60% respectively.

Prevalence of type- A in prehypertensiveswas 61.54% similar to studies done by Jane Irvine et

al., Shekelle RB et al, [25] where the prevalence of type-A in prehypertension hypertension was 78% and 74% respectively. And a marked increase seen in Mangalavalli et al, 26 which was 85.2%.

Prevalence of type- B in normotensives was 60%, similar to Aliya Hisam et al. [21], who showed a higher prevalence of type- B in normal people, which was 89.2%. And a decreased prevalence of type-B in prehypertensives was seen, whichwas 40% similar to the low prevalence rate seen in Mangalavalli et al. [26], were it was 14.8% type-B in prehypertensives.

This can be explained by the fact that type-A persons are found to have hyperactive sympathetic nervous system [10] and are at risk in developing cardiac problems and hypertension.Stress in work environment has a varied impact on Type A vs Type B personality status of the subjects [27]. In the present study prevalence of prehypertension was 40% which was slightly higher than that of Asmathulla et al. [28] where the prevalence of PHT was 22%.

In the present study the TP was decreased in prehypertensives, both type- A and type-B.(GROUP II and IV). HF nu, LF and HF was decreased but LF nu and LF/HF ratio was increased as compared to normotensives. This is in accordance with studies done by G.K.Pal et al, Surekharani Chinagudi et al.(29,30) In the present study the TP was decreased in prehypertensives, both type- A and type-B (group II and IV), HF nu , LF and HF was decreased but LF nu and LF/HF ratio was increased as compared to normotensives during physical and mental stress. LF/HF ratio is more during mental stress than during physical stress. Similar results were seen in Kaur et al. [31] where there was a decrease in HF and increase in LF/HF ratio but LF. Further the LF/HF ratio was increased more during mental stress than during physical stress.

In our study, the effect of type–A and type-B on normotensives and prehypertensives showed a statistically significant increase in SBP,DBP,LF nu and LF/HF ratio and a significant decrease in TP and HF nu, at rest, during physical and mental stress, wherein the increase was much more in mental stress. This is in accordance with the study by Kaur et al. [31] done in normotensives alone.

This study is unique in that no studies were done to assess the effect of physical and mental stress on HRV in type-A and type-B individuals with prehypertension. In our study we had compared the effect of HRV at rest, during physical stress and mental stress in type-A and type-B prehypertensives which showed a statistically significant increase in TP, LF nu, and LF/HF ratio and a significant decrease in HF nu and HF. This difference was more noticed during mental stress than physical stress when compared with at rest values. Further, the LF/HF ratio which is the indicator of sympathovagal balance is higher among type –A prehypertensives as compared to type –B prehypertensives.

Conclusion

From the results of our study, we can conclude that there is an increased prevalence of type-A and prehypertension in the vulnerable young adult population as they are prone to more stress due to either work environment, life style, nuclear family, genetic predisposition, personality trait, sedentary life or obesity etc. Type-A have a hyperactive sympathetic system hence are more prone to develop prehypertension and later hypertension and other cardiac diseases.

The sympathovagal balance was shifted towards an increased sympathetic system and vagal inhibition which was seen more in type-A individuals than type-B by measuring and comparing the HRV. This increased sympathetic activity and vagal withdrawal was exponentially high during mental stress than during physical stress as compared to the at rest values.

We can hence conclude that the effect of stress, on frequency parameters of HRV in type-A individuals with prehypertension in young adults was much more when compared to type-B individuals. Further the effect of both mental and physical stress, was more than the at rest values, in which mental stress had a greater impact. Hence any individual has to learn to cope up with stress by life style modifications, personality modification, regular physical exercises, deep breathing, pranayama etc. so as to not only modify his or her personality and their reaction to stressful events but also to prevent the development of hypertension and other cardiac diseases. The main purpose of our study was to identify the people with altered HRV and prehypertension and advise them to take preventive measures as mentioned above and thereby preventing the development of hypertension and other cardiac diseases in future and increase the longevity of our society.

Prior publication: NIL

Support: NIL

Conflicts of interest: NIL

Permissions: NIL

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