# Cardiovascular Response To Bruce Submaximal Exercise Test And Its Correlation With Anthropometric Variables In Young Adults.

**Mohd Yusuf*, RB Kamal**, Manish Bajpai***, Piyush Saxena****,Aquil Ahmad*******

*Assistant Professor, Department Of Physiology, Himalayan Institute Of Medical Sciences, SRHU, Dehradun, **Professor, Department Of Physiology, M.L.N. Medical College, Allahabad, ***Professor, Department Of Physiology, K.G. Medical University, Lucknow, ****Associate Professor, Department Of Medicine, M.L.N. Medical College, Allahabad, *****Assistant Professor, Department Of Physiology, Maulana Azad Medical College, New Delhi

**Abstract:** Background: Cardiovascular response to exercise if abnormal may serve as a future predictor of cardiovascular morbidity in otherwise normotensive individuals. So, the study was designed (i) To assess the cardiovascular response in Bruce sub-maximal exercise tests. (ii) to see correlation between cardiovascular response and anthropometric variables. Method: 125 males 18-25 years underwent first three stages of the original Bruce protocol. Heart rate, blood pressure and ECG were recorded before, during each stage and after taking the treadmill test. Results: During the exercise heart rate and systolic BP rose and diastolic BP fell. Correlation analysis showed highly significant positive correlation between BMI and pre-exercise systolic BP, post-exercise heart rate and post-exercise systolic BP in. ECG showed no significant ST/T or rhythm changes during or after the exercise. Conclusion: Higher BMI was found to be correlated with higher resting systolic BP, higher post-exercise heart rate as well as higher post-exercise systolic BP. [Yusuf M Natl J Integr Res Med, 2019; 10(5): 86-90]

**Key Words:** BMI, cardiovascular response, sub-maximal exercise, treadmill test

**Author for correspondence:** Mohd Yusuf, Assistant Professor, Department Of Physiology, Himalayan Institute Of Medical Sciences, SRHU, Dehradun, 248140. E Mail: yusufmd123@gmail.com, M: 8287231991

**Introduction:** Dynamic exercise produces the most striking burden on cardiovascular (CV) system out of any of the various stresses encountered in normal life. One of the earliest and perhaps obvious observations about the CV system is that the heart rate (HR) and blood pressure (BP) rise during exercise. Mean and systolic blood pressure (SBP) increase with increasing exercise intensity. While during dynamic exercise total peripheral resistance falls than its value at rest which leads to decrease in the diastolic blood pressure (DBP). The study of CV response to exercise provide an excellent method to improve the understanding of the CV system operation during exercise[1-4].

The exercise stress test has several indications, among which the assessment of the levels of functional capacity to participate in vocational, leisure and sport activities, as well as to observe the arterial pressure response to exertion[5,]. Individuals normotensive at rest but show an exaggerated BP response to exercise are at greater risk of developing hypertension in future[6]. Excessive amount of body fat exerts an unfavourable burden as well as hindering action towards cardiac function particularly during exhaustive exercise.

A positive correlation was observed between the resting SBP and DBP and age, weight, height and BMI. Arterial BP during physical exertion has a direct relationship with age, weight, height, and BMI[7]. These facts make early identification of persons at increased risk for developing hypertension a priority so that life style modifications can be initiated at an early stage to interrupt the costly cycle of hypertension and prevent the reduction in quality of life associated with this chronic disease[8]. Maximal aerobic treadmill tests require reasonable level of fitness, longer time and are expensive. It is not recommended for recreational athletes and cardio-respiratory compromised individuals.

So, the present study was designed to assess the CV response to Bruce submaximal treadmill exercise test (BSET) and to see correlation between the anthropometric variables.

**Material And Methods:** The study was conducted in Clinical Physiology Lab, Department of Physiology, Moti Lal Nehru Medical College Allahabad, Uttar Pradesh.

125 apparently healthy males were selected for the study after applying inclusion and exclusion criteria.

Inclusion Criteria: Male -18 to 25 years of age, pre-exercise BP <140/90 mmHg and having a normal pre-exercise ECG were included in the study. In addition, subjects had to fill a Physical Activity Readiness (PAR-Q)[9] Form before exercise. Subjects who had answered NO to all the questions were selected for the study.

Exclusion Criteria : Subjects with history suggestive of CV, respiratory, metabolic, musculo-skeletal and emotional disorders were excluded.

Evaluation -Informed written consent was taken from all the subjects. The study was approved by the Institutional Ethical Committee (IEC). Subjects were divided into small groups and then they were familiarized with the instruments. Experimental protocol was explained to them in detail. They were also given a trial run on treadmill to relieve the anxiety related to the treadmill running during actual testing and data collection[10]. For treadmill testing guidelines from American College of Sports Medicine (ACSM) were followed.

Weight was measured nearest to 0.1 kg using calibrated weighing machine in light clothing and bare feet and height nearest to 0.5 cm was measured using measuring scale in centimetres which was fixed to the wall.

Body mass index was calculated using Quetlet's index: BMI=Weight (kg) / height ($m^2$).

The ambient temperature of the laboratory was maintained between 20-25$^0$C. All the measurements were taken at same time of the day (between 9:00-11:00 am) to avoid diurnal variation.

Pre-exercise BP Measurement: - measured in supine position after the rest of 10 minutes by both palpatory and auscultatory method in right arm using mercury manometer following the standard procedure.

Pre-exercise ECG and HR Measurement: - Instrument used: PC Based Stress Test Analysis (Stress-INVX1) system (CARDIVISION Exercise Stress Test System and Rest ECG Analysis System- developed by MEDICAID SYSTEMS 389, Industrial Area, Phase-II, and Chandigarh, India.)

The device is PC based which records 12 lead ECG and HR through wireless communication when connected to the subject with electrodes.

Once the Patient Information Entry was over then we selected on the screen to record the 12-lead ECG. Under Record mode a data collection screen appears comprising of 12-lead real time ECG, and on the right corner of the screen current HR is displayed.

For recording of pre-exercise ECG standard 12-Lead System was followed. Subjects were asked to lie on their back and to undress up to the waist. The subjects with hairy chests were instructed to shave their chest hair before appearing for exercise testing. The places, where electrodes were to be placed, were wiped with alcohol to remove the oil and dirt. Then self-adhesive disposable electrodes were used on chest and color coded electrodes were used for arms and limbs[11].

Exercise ECG And HR Measurement: - Mason-Likar modification of the standard 12-Lead System was followed[12]. HR and ECG were recorded automatically during the exercise and displayed on computer screen in real time.
Exercise BP Measurement: - BP during the exercise was measured in the right arm by ambulatory mercury manometer. SBP and DBP were measured at the end of every stage manually by mercury manometer[13-14].

Bruce Submaximal Treadmill Test (BSET)[15]: Subject perform first three stages of Bruce Protocol

**TABLE-1-Stages of the BSET**

| STAGES | TIME [MIN] | SPEED [MPH] | GRADE [%] |
|---|---|---|---|
| I | 0-3 | 1.7 | 10 |
| II | 3-6 | 2.5 | 12 |
| III | 6-9 | 3.4 | 14 |

CV variables were recorded at regular intervals. HR gets automatically recorded. BP recorded at the 2 minutes mark in each stage. RPE were recorded at the 2:45 minute mark of each stage. Verbal communication with the subject was maintained throughout the test. The test was terminated if the subject reached the 85%HRmax or if the subject feels fatigued. When the test was terminated, passive cool down was done in supine posture. Monitoring of the HR, BP, and RPE was continued until the subject recover. A HR below100 BPM is an arbitrary value used to gauge recovery.

Statistical analysis: Data were summarized as Mean ± SD (standard deviation). Groups were compared by Student's t test. Groups were also compared by repeated measures one-way analysis of variance (ANOVA) and the significance of mean difference between the groups (periods) was done by Tukey's post hoc test. A two-tailed (α=2) p value less than 0.05 ($p<0.05$) was considered statistically significant. Analyses were performed on SPSS software (PSAW, Windows version 18.0).

**Result:** Anthropometric measurements of the participants are summarized in table-2.

**Table 2: Anthropometric Measurements of subjects.**

| Basic characteristics | Range | Statistic (mean ± SD) |
|---|---|---|
| Age (years) | 18- 25 | 21.17 ± 1.98 |
| Height (cm) | 162- 187 | 172.26 ± 4.62 |
| Weight (kg) | 51- 79 | 64.42 ± 6.19 |
| BMI (kg/m$^2$) | 18.17- 25.06 | 21.70 ± 1.79 |

**Table 3: Effect of BSET on CV parameters (n=125) of subjects at different stages**

| Clinical parameters | Pre test (Mean ± SD) | Stage I (Mean ± SD) | Stage II | Stage III | F value | p value |
|---|---|---|---|---|---|---|
| HR(beats/min) | 75.57 ± 3.61 | 112.08 ± 7.48 | 130.17 ± 8.58 | 164.31 ± 5.26 | 9809.58 | <0.001 |
| SBP (mmHg) | 122.61 ± 6.21 | 141.47 ± 7.04 | 155.62 ± 9.22 | 169.97 ± 8.72 | 3183.09 | <0.001 |
| DBP (mmHg) | 75.42 ± 3.55 | 74.75 ± 3.64 | 73.58 ± 3.81 | 72.11 ± 4.07 | 199.66 | <0.001 |

**Table 5-Correlation of BMI with CV parameters (Mean ± SD, n=125) of the subjects**

| Clinical parameters | r | P |
|---|---|---|
| Pre-exercise SBP | 0.58 | 0.001 |
| Pre-exercise DBP | 0.30 | 0.007 |
| Post-exercise SBP | 0.49 | 0.001 |
| Post-exercise DBP | 0.34 | 0.001 |
| Post-exercise HR | 0.44 | 0.001 |

**Discussion:** CV parameters change in our present study, showed rise in HR and SBP and fall in DBP with increasing severity of exercise, were in agreement with the changes described by Bassett DR et. al.[1], Krogh & lindhard[2], Harold M[3], fletcher GF et. al.[4], Pande SS et. al.[16] in their respective studies and also Dabade SK et. al.[17] in their sample of subjects without family history of hypertension. None of the abnormal CV responses as described by Dlin RA et. al.[6] and Dabade SK et. al.[17] were found in our study.

Stage wise comparison of CV parameters with Pande SS et. al.[16] showed significantly higher pre-exercise HR as well as HR in all the first three stages in their sample as compared to our sample. Difference between pre-exercise SBP and SBP in stage I and II was not significant while it was significantly lower in stage III in their sample as compared to our sample. Pre-exercise DBP as well as DBP in first three stages was significantly higher in their sample as compared to our sample. DBP fall from their pre-exercise value across all the three stages in our sample while Pande SS et. al.[16] reported fall in DBP in stage II which increased once again in stage III. Comparing the CV parameters with the sample of male subjects without family history of hypertension in the study done by Dabade SK et. al.[17] revealed non-significant difference in pre-exercise HR, stage I and II HR while it was significantly lower in stage III in their sample as compared to our sample. Pre-exercise SBP was significantly lower, stage I SBP was higher while that of stage II and III was not different significantly in their sample as compared to our sample. Pre-exercise DBP was lower, stage I DBP was not significantly different while DBP in stage II and III was significantly higher in their sample as compared to our sample. On comparing the sample of males with family history of hypertension revealed significantly higher HR at pre-exercise and stage II, it was not significantly different in stage I while it was significantly lower in stage III in their sample as compared to our sample. Pre-exercise SBP was significantly lower, while that of stage I, II and III was significantly higher in their sample as compared to our sample. Pre-exercise DBP was not different in two samples while stage I, II and III DBP was significantly higher in their sample as compared to others.

Since the CV parameters depend on multiple factors such as genetic, nutritional, socio-economic, anthropometric and also on level of physical fitness means that there can be a wide range for any of the parameter. So, the values in our study as compared to other studies can be taken as normal range as the difference can arise due to the factors as described above or may be due to different methodologies used in different studies.

Reddy et. al.[18] and Balogun et. al.[19] have found that BMI and triceps skin fold thickness are strong determinants and positively correlated with SBP and DBP. In our study we found BMI to be positively correlated with pre-exercise SBP and DBP but correlation with DBP was weak. Pande SS et. al.[16] also reported positive correlation between BMI and DBP which was weak in our study. This correlation in our study indicates inhibitory action of increasing BMI on CV system at rest and also during exercise indicated by more work done by heart for same amount of workload.

According to Becker MDE M et. al.[7] there is a positive correlation between resting SBP and resting DBP with height, weight, age and BMI. And arterial BP response to physical exertion also has a direct relationship with age, weight, height, and BMI while the DBP has a direct relationship with individual's age. In our present study we found significant positive correlation between BMI and pre-exercise SBP and between BMI and post-exercise SBP and post exercise HR only and not with other anthropometric variables. A significantly positive although weak correlation was also found between BMI and pre-exercise DBP and post-exercise DBP as well. Grant S, et.al.[20] in their study concluded that age variation has to be large if high correlations are to be expected. Grant JA, et.al.[21] in their study concluded that calculation of correlation coefficients depends on the variance and range of a group of scores, any combination of less variance or range will result in poorer correlations. Since the age group of our subjects were from 18-25 this could be one reason for weak correlation in our present study.

Limitations: Wider age range as well as inclusion of female subject in future studies will lead to better understanding of CV response to exercise.

**Conclusion:** Submaximal treadmill exercise tests are reliable, safe and valid methods to assess CV response to exercise. Exercise testing provides an opportunity for early identification of future risk of CV morbidity. Abnormal CV response to exercise should be followed by lifestyle modification and pharmacological intervention if required.

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