ORIGINAL RESEARCH PAPER

Physiology

COMPARATIVE STUDY OF EXERCISE STRESS TEST ON CARDIOVASCULAR AUTONOMIC FUNCTIONS BETWEEN MALES AND FEMALES - A CROSS SECTIONAL STUDY

KEY WORDS: males and females, body mass index, exercise stress test, autonomic function

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ABSTRACT

Background: Exercise stress test is a simple, reliable and noninvasive test which detects the coronary artery disease even before the symptoms arise among both males and females. Hence this test was used to assess the impact of exercise stress test on cardiac autonomic function among males and females.

Objectives: To compare the cardiac autonomic functions between the males and females among normal, overweight and obese individuals in South Indian population.

Methods: A cross sectional study in department of Cardiology and Master Health Checkup in Chennai medical College and hospital, Trichy, a tertiary care teaching hospital during December 2015 to December 2016. Study population includes healthy participants aged between 18-70 years of age from both genders with BMI more than 20 kg/m2. Participants who gave history of alcohol consumption, smoking, hypertension, diabetes mellitus, pregnant and lactating mothers and cases with psychiatric disorders were excluded from the study. Total participants included were 135. Data was entered and analyzed using Statistical Package for Social Sciences version 18. Descriptive statistics and analysis of variance tests were used, appropriately to test the statistical significance.

Results: Overweight females had significantly low duration of exercise and MET and obese females had significantly low hear rate at peak of the exercise, duration of exercise, MET and HRR at one and three minutes compared to the individuals with similar BMI categories. Females with normal BMI were found to show no significant difference in any of the observed parameters.

Conclusion: Overweight and obese females were comparative at higher risk of developing cardiac disorders compared to overweight and obese males. To reduce the burden of cardiovascular disease in the population, these high risk populations should be targeted first by health education and promoting weight reduction.

BACKGROUND

Industrialization and westernization of life style and dietary practices are responsible for the global rise in Cardio Vascular Diseases (CVD). High calorie intake and physical inactivity together results in increasing overweight and obesity. Many studies have proven that CVD has been correlated positively with increased prevalence of hypertension, diabetes mellitus, dyslipidemia, obesity, smoking and family history, if this trend of cardiac risk factors continue, the cardiovascular mortality may further increase in near future.[1] Hence risk factor identification in normal individuals is of prime importance in the primordial prevention of CVD.

When compared to developed countries, the increased rate of CVD is almost double in the developing countries like India. Particularly, the younger generations are more affected in developing countries accounting for almost 52% of deaths from CVDs which occur before 70 years of age. The rural areas are also equally affected. A survey conducted in 45 rural villages states that 32% of all deaths were due to CVD.[2] As per the Global Burden of Disease study, the age-standardized CVD death rate is 272 per 100 000 population in India compared to the global average of 235 per 100 000 population.[3]

Occult coronary artery disease is a critical problem in the western world and also in India.[4] Exercise stress test is a simple, noninvasive test which detects the coronary artery disease even before the symptoms arise.[5] It is one of the commonly used test for assessing the autonomic balance as there is an interaction between autonomic nervous system and the cardiovascular system during exercise. Many researchers have used exercise stress test for assessing the autonomic function in diseased individuals[6,7].

The prevalence of cardiovascular disease is more in individual with higher BMI[8]. Obesity is emerging as a global epidemic in children and adults called "New world syndrome." Obesity is said to be due to the imbalance between calorie intake and energy expenditure. Since, autonomic nervous system (ANS) is involved in both energy metabolism and in the cardiovascular regulation, it is believed that alterations in ANS may be involved in the pathophysiology of obesity at various levels from promotion of obesity to its role in cardiovascular diseases[9]. So, obesity is an independent risk factor for coronary artery disease, arrhythmias, and sudden death[10].

The purpose of our study is to compare the cardiac autonomic functions between the males and females with normal BMI, overweight and obese individuals in South Indian population by measuring the resting heart rate, resting blood pressure, and peak exercise heart rate, blood pressure response to peak exercise, metabolic equivalent and exercise duration.

METHODS

This study was conducted as a cross sectional study in the Department of Cardiology and Master Health Checkup in Chennai medical College and hospital, Trichy, a tertiary care teaching hospital during the period of December 2015 to December 2016. Study population includes healthy participants aged between 18-70 years of age from both genders with BMI more than 20 kg/m^2. Participants who gave history of alcohol consumption, smoking, hypertension, diabetes mellitus, pregnant and lactating mothers and cases with psychiatric disorders were excluded from the study. The sample size was calculated using mean maximum HR for various BMI categories as reference and the calculated sample size was 41 in each group. Considering the non-response rate of 10%, the total sample size was 135.

All participants were thoroughly explained about the study and its need in their native language and informed written consent were obtained from them. The study population was divided into three groups as normal, overweight and obese according to their BMI. The participants were clearly

instructed to avoid heavy meals, caffeinated drinks, for at least 3 hours prior to the test.[11] After obtaining the demographic details about the subject, a brief instruction about the test procedure was given.

BEFORE EXERCISE:

The participants were asked to take rest for 5 minutes in the supine position with eyes closed. At the end of the 5 minutes, resting heart rate and blood pressure was recorded. Resting heart rate were recorded by counting the pulse in the radial artery for one full minute. The normal resting heart rate ranges between 60-100 beats per minute. The resting heart rate ≥ 100 beats/minute was considered as abnormal. The maximum predicted HR was calculated as 220 minus age.[12] Resting blood pressure was recorded 3 times by auscultation method by using mercury sphygmomanometer (Diamond). The averages of the 3 readings were used.

DURING EXERCISE:

Treadmill exercise test was performed according to the Bruce protocol in WISPER MILL 594 XL. Individuals were encouraged to do the exercise until they experience limiting symptoms, even if 85% of maximum predicted heart rate was achieved. The heart rate and Blood pressure were recorded during peak exercise. The exercise duration and metabolic equivalent level were recorded. The exercise was terminated when the subject experienced chest pain, syncope, dyspnea, and fatigue, changes in ECG, failure to increase systolic blood pressure more than 10 mm Hg or fall of blood pressure below the resting level.[13]

AFTER EXERCISE:

After cessation of exercise, the subject was asked to lie down in a couch. The heart rate and blood pressure were recorded within one minute and at three minutes of post exercise. Then, the resting blood pressure and heart rate, peak blood pressure and heart rate, heart rate recovery and blood pressure at 1 minute & 3rd minute, exercise capacity, and duration of exercise were calculated. The subjects were monitored for 6-8 minutes until heart rate, blood pressure, subject's symptom returns to pre-exercise level because the ECG changes that do not occur during the exercise might occur during the recovery period.[14]

Data was entered and analyzed using Statistical Package for Social Sciences (SPSS) version 18. Descriptive statistics and ANOVA tests were used, appropriately to calculate the statistical significance. P value of< 0.05 was considered as statistically significant.

RESULTS

Among individuals with normal BMI, there were no significant differences noted with respect to males and females on assessing the parameters like heart rate, systolic blood pressure, diastolic blood pressure, duration of exercise, MET, HRR and Chronotropic competence during the peak exercise and after one and three minutes of exercise (Table 1).

Table 1: Comparison Of Parameters Among Individuals With Normal Bmi With Respect To Gender

Event of exercise	Exercise parameters	Male N=38	Female N=25	P value
Peak Exercise	HR	151.88 22.41	162.52 20.37	0.066
	SBP	164.25 15.17	148.39 19.10	0.001
	DBP	97.50 8.09	87.83 10.43	0.0001
1 min after Exercise	HR	123.63 23.47	126.26 20.32	0.654
	SBP	162.25 15.44	146.96 20.77	0.001
	DBP	96.50 V 8.93	86.52 9.35	0.0001
3 mins after exercise	HR	123.90 12.90	104.30 11.97	0.472
	SBP	143.00 16.67	128.70 18.41	0.002
	DBP	88.15 8.19	82.17 11.66	0.020
Indicators related to Exercise performance	Duration of exercise	8.27 2.18	8.01 2.29	0.654
	MET	11.18 10.72	9.21 2.34	0.389
	HRR after 1 mins	28.83 11.11	35.04 9.32	0.027
	HRR after 3 mins	48.68 14.99	59.52 12.06	0.004
	Chronotropic competence	146.60 9.16	153.59 11.15	0.009

HR- Heart Rate, SBP- Systolic blood pressure, DBP- diastolic blood pressure, HRR- Heart rate recovery, MET- Metabolic equalents

Among individuals with overweight BMI, there were no significant differences noted with respect to males and females on assessing the parameters like heart rate, systolic blood pressure, diastolic blood pressure, heart rate recovery and chronotropic competence during the peak exercise and after one and three minutes of exercise whereas duration of exercise and MET were found to be significantly low among females (Table 2).

Table 2: Comparison Of Parameters Among Overweight Individuals With Respect To Gender

Event of exercise	Exercise parameters	Male N=51	Female N=18	P value
Peak Exercise	HR	155.79 17.45	150.82 28.27	0.440
	SBP	163.10 16.68	155.45 19.16	0.177
	DBP	98.33 7.38	96.36 10.27	0.451
1 min after Exercise	HR	126.83 21.69	125.91 23.05	0.899
	SBP	164.45 15.39	154.55 15.08	0.054
	DBP	96.55 8.07	92.73 10.09	0.171
3 mins after exercise	HR	105.83 19.83	101.82 18.18	0.536
	SBP	145.86 15.22	140.00 10.95	0.228
	DBP	87.41 8.9	87.27 7.86	0.961
Indicators related to Exercise performance	Duration of exercise	8.62 1.80	6.5645 2.60	0.002*
	MET	9.73 1.73	7.75 2.61	0.002*
	HRR after 1 mins	30.59 13.74	25.18 17.26	0.255
	HRR after 3 mins	52.22 13.35	48.18 19.37	0.397
	Chronotropic competence	147.49 7.77	146.75 6.50	0.765

HR- Heart Rate, SBP- Systolic blood pressure, DBP- diastolic blood pressure, HRR- Heart rate recovery, MET- Metabolic equalents

Among individuals with obese BMI, there was a significant differences noted with respect to males and females on heart rate at peak exercise alone whereas there were no significant difference noted in assessing the parameters like heart rate after one and three minutes of exercise, systolic blood pressure, diastolic blood pressure and chronotropic competence during the peak exercise and after one and three minutes of exercise. Statistically significant differences were noted in duration of exercise and MET and Hear rate recovery at one and three minutes which were found to be significantly low in females compared to males (Table 3).

Table 3: Comparison Of Parameters Among Obese Individuals With Respect To Gender

Event of exercise	Exercise parameters	Male N=30	Female N=16	P value
Peak Exercise	HR	155.64 16.33	136.77 23.42	.003*
	SBP	159.39 18.19	155.38 23.31	0.538
	DBP	97.58 8.3	94.62 11.98	0.344
1 min after Exercise	HR	125.30 23.89	116.38 22.25	0.252
	SBP	163.33 13.84	159.23 20.6	0.437
	DBP	98.18 7.27	96.15 11.21	0.471

3 mins after exercise	HR	105.18 19.42	98.46 17.73	0.285
	SBP	148.79 14.31	143.85 19.81	0.351
	DBP	90.30 8.83	86.92 12.51	0.306
Indicators related to Exercise performance	Duration of exercise	8.41 2.1	5.22 1.85	0.000*
	MET	9.51 2.0	6.37 1.8	0.000*
	HRR after 1 mins	32.55 14.51	20.38 9.08	0.008*
	HRR after 3 mins	51.33 14.76	38.38 10.19	0.006*
	Chronotropic competence	146.46 7.94	145.42 6.8	0.679

HR- Heart Rate, SBP- Systolic blood pressure, DBP- diastolic blood pressure, HRR- Heart rate recovery, MET- Metabolic equalents

DISCUSSION

In our study, it had been correlated that the resting heart rate, blood pressure, HRR, exercise capacity and chronotropic competence during exercise are all significantly less in females compared with that of males in all the three groups. In our study men had increased systolic and diastolic BP. This was supported by Wheatley et al who found that that men had higher systolic BP with no difference in diastolic BP when compared to females.[15] This may also be explained by the fact that males normally have a good physical activity compared with that of females. Similar results have also been observed in a study conducted by Fu Q16 et al who found that the systolic BP was lower in females and diastolic BP was similar between male and females which states that the women had blunted sympathetic neural response when compared to men.[16] Gulati et al found that an exercise capacity was lower in females which is an independent predictor of death greater than what has been previously established among men.[17]

In our study, the resting heart rate seems to be more in women than in men. The resting blood pressure is lower in women than in men. Women show several anatomic and physiologic characteristics that distinguish from men during exercise. Women have less muscle mass, and more fat mass than men for a given body size Women tend to use a greater percentage of fats during exercise. Blood volume, stroke volume, and cardiac output are all lower in women than in men. During exercise, the, estrogen and progesterone, can influence ventilation, substrate metabolism, and thermoregulation.[18] Ogawa et al., in their study conclude that differences in stroke volume is the primary cause of sex differences in cardiac output.[19] The same fact is supported by previous study conducted by Fleg et al[20]. Since our study did not involve estimation of estrogen and progesterone nor was done in a particular phase of menstrual cycle, we could not relate the gender differences to hormonal influences. The fitness level of the study participants was one of the strong factors to influence the results.

Males normally have a good physical activity compared with that of females. The fitness level of the study participants was one of the strong factors to influence the results. Physical fitness and regular physical activity can results in increased cardiac output by increasing the stroke volume, irrespective of gender or age. In our study group, the level of physical fitness and training is not known; hence, we are not able to comment on it with respect to gender.

CONCLUSION

To conclude, overweight females had significantly low duration of exercise and MET and obese females had significantly low hear rate at peak of the exercise, duration of exercise, MET and HRR at one and three minutes compared to the individuals with similar BMI categories. Females with normal BMI were found to show no significant difference in any of the observed parameters. This shows that overweight and obese females were comparative at higher risk of developing cardiac disorders compared to overweight and obese males.

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