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Gender Differences in Cardiovascular Responses to Isometric Exercises in Normotensive Subjects

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ABSTRACT

The study is aimed to determine the gender differences in cardiovascular responses to isometric exercise. 25 normotensive females and 25 normotensive males (age – 20-25 years) were made to perform handgrip exercise. The following parameters were studied – i) Maximum voluntary contraction (MVC), ii) Endurance time (ET), iii) Heart rate, systolic blood pressure, diastolic blood pressure and cardiac work was measured before and immediately after the handgrip exercise at 40% MVC. iv) all the above parameters were compared in between males and females. Results-1) MVC was significantly high in males as compared to females. 2) Endurance time was found significantly high in females as compared to males. 3) The heart rate, systolic blood pressure and cardiac work increased significantly after hand grip exercise in both, males and females as compared to before exercise. Sympathetic activity is accelerated after isometric type of exercise. The responses were greater in males as compared to females.

KEYWORDS_– *Cardiovascular responses, isometric exercices, normotensive*..

INTRODUCTION:-

The proposed mechanisms attempting to explain gender differences in cardiovascular responses are numerous and conflicting. Moreover some studies have also found that gender did not influence sympathetic neural reactivity to stressors such as isometric handgrip exercise.[1] Hence considering the

importance of isometric handgrip exercise and the contradictory findings from previous research, we undertook the present study.

AIMS and OBJECTIVES:-

The study was undertaken with following aims and objectives –

A)To study the following parameters in males and females :- 1) Maximum Voluntary Contraction (MVC), 2) Endurance Time (ET), 3) Heart rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), and Cardiac Work (CW) before and after the handgrip exercise at 40% MVC till fatigue.

B) To compare all the above parameters between males and females.

MATERIAL and METHODS:-

25 normotensive untrained females and 25 normotensive untrained males between the age group 21-25 years are included in the study.

	Males (n=25)	***Females (n=25)***
Age (years)	*22.24 ± 1.67*	*22.16 ± 1.77*
Height (cm)	*166.12 ± 4.89*	*161.92 ± 5.37*
Weight (Kg)	*60.2 ± 4.19*	*57.44 ± 4.68*

Exclusion Criteria:-

Subjects with pulmonarydisorders, cardiovascular disorders or any other illness.

Subjects addicted to smoking, alcohol, or any other addiction.

Pregnancy in the case of females.

All selected females are studied in the preovulatory phase of menstrual cycle.

Prior to the procedure a written informed consent is signed by the subjects, as willingness to volunteer in the study.

Apparatus:- Handgrip dynamometer, ECG machine, Weighing machine, Sphygmomanometer, Stethoscope, Measuring tape

Procedure:-

All subjects are studied between the time 11 am – 2 pm.

1) MVC (Kg):- Maximum voluntary contractions are obtained by participants dominant hand. The single best voluntary contraction of the three trials is determined.[1]

2) ET (Sec):- All the subjects are instructed to maintain 40% MVC, isometric handgrip contraction with uniform intensity till failure and time is recorded.[1]

3) HR (beats / sec):- It is recorded using Lead II of ECG.

4)SBP and DBP (mm Hg):- is measured by auscultatory method.

5)CW:- Calculated using formula – CW = HR x [DBP + 1/3 (SBP – DBP)].[2]

The average age, height and weight of the males and females in our study was as follows:-

Statistical analysis - Done by applying paired ‘t’ test.

Observation and results:-

Table 1:-

	Males n=25	***Females n=25***	***'t' - value***	***'p-value'***	***Significance***
MVC	*36.6 ± 5.85*	*20.44 ± 5.40*	*10.15*	*< 0.01*	*Significant*
ET	*117 ± 18.82*	*151.48 ± 36.3*	*4.216*	*< 0.01*	*Significant*

Table 2:- Comparison of HR, SBP, DBP, CW in males and females before handgrip exercise.

	Males (n=25)	***Females(n=25)***	***'t' value***	***Significance***
HR	*71.4 ± 2.42*	*70.44 ± 2.14*	*1.49*	*Not Significant*
SBP	*115 ± 3.8*	*114.24 ± 3.57*	*0.77*	*Not Significant*
DBP	*74.4 ± 4.4*	*72 ± 4.28*	*1.96*	*Not Significant*
CW	*6279.12 ± 310.22*	*6163.68 ± 294.76*	*1.517*	*Not Significant*

Table 3:-

	Males	***Females***
1) HR – Before Exercise	*71.4 ± 2.42*	*70.44 ± 2.14*
After Exercise	*74.52 ± 2.58*	*72.4 ± 2.12*
't' value	*14.28*	*11.66*
Significance	*Significant*	*Significant*
2) SBP – Before Exercise	*115.04 ± 3.8*	*114.24 ± 3.57*
After Exercise	*118.96 ± 4.29*	*116.16 ± 4*
't' value	*14.50*	*6.53*
Significance	*Significant*	*Significant*
3) DBP – Before Exercise	*74.4 ± 4.4*	*72 ± 4.28*
After Exercise	*77.36 ± 4.31*	*73.36 ± 3.99*
't' value	*11.33*	*7.14*
Significance	*Significant*	*Significant*
4) CW – Before Exercise	*6279.12 ± 310.22*	*6163.68 ± 294.76*
After Exercise	*6796.83 ± 301.97*	*6343.89 ± 278.31*
't' value	*22.71*	*5.1*
Significance	*Significant*	*Significant*

Table 4:-

Comparison Of HR, SBP, DBP, CW in Males And Females After Handgrip Exercise

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	Males (n=25)	***Females(n=25)***	***'t' value***	***Significane***
HR	*74.52 ± 2.58*	*72.4 ± 2.12*	*3.17*	*Significant*
SBP	*118.96 ± 4.29*	*116.16 ± 4*	*2.39*	*Significant*
DBP	*77.36 ± 4.31*	*73.36 ± 3.99*	*3.40*	*Significant*
CW	*6796.83 ± 301.97*	*6343.89 ± 278.31*	*5.51*	*Significant*

RESULTS –

1)The Maximum Voluntary Contraction (MVC) generated by females at rest was significantly less than men as shown in **Table 1.**

2)Table-1 also shows that the Endurance Time (ET) was significantly longer in females than men at 40% MVC.

3)There was no significant difference in HR, SBP, DBP, and CW between genders at rest (before exercise)**(Table 2).**

4)The HR, SBP, DBP, CW increased significantly in males as well as females after exercise in the present study as shown in **Table-3**.

5)Table -4 shows that the increase in HR, SBP, DBP and CW immediately after isometric exercise, till fatigue, was significantly more in men as compared to females

DISCUSSION:-

The Maximum Voluntary Contraction (MVC) generated by females at rest was significantly less than men as shown in **Table -1** indicating that men had greater forearm muscle strength than women. This may be because females have less muscle mass than men. This is due to the male hormone testosterone, which causes increase in muscle development and protein formation. The musculature thereby increases in males after puberty, averaging about 50% increase in muscle mass than females.[3]

The Endurance Time (ET) was significantly longer in females than men at 40% MVC,

Table- 1. Vasodilatation occurs in active muscle during sustained contraction. The mechanical compression of these vessels occurs due to increased intramuscular pressure. Thus the blood flow to the

muscle is reduced and hence decreased delivery of oxygen and glucose and insufficient removal of metabolic byproducts which contributes to early muscle fatigue. Females have less muscle mass hence low absolute muscle force while performing exercise. Low absolute muscle force therefore less mechanical compression of vasculature hence less imbalance between blood supply and demand and delayed fatigability i.e. prolonged ET.[4,5]

Table -2 shows that there was no significant difference in HR, SBP, DBP, and CW between genders at rest (before exercise).

The HR, SBP, DBP, CW increased significantly in males as well as females after exercise in the present study as shown in **Table-3**. 1) The increase in HR on exercise is due to – a) Central reflexes – Increased activity of limbic system and motor cortex due to Psychic stimuli causing increased sympathetic discharge and decreased vagal tone. b) Peripheral reflexes originating from exercising muscle also causes increase in HR as soon as exercise begins. c) Release of Adrenaline and Nor adrenaline from adrenal medulla in response to stress.[6] 2) The increase in SBP is due to increase in cardiac output on exercise. The increase in cardiac output is due increase in HR and stroke volume that increases on exercise.[6] 3) The DBP depends on the peripheral resistance hence vasoconstriction in tissues other than active muscle results into increase DBP on exercise. This increase in blood pressure may well have a functional importance in maintaining the supply of blood to the contracting muscle.[4] 4) CW = HR x [DBP + 1/3 (SBP – DBP)]. As HR, SBP and DBP all three increase on exercise the CW also is increased.

Table -4 shows that the increase in HR, SBP, DBP and CW immediately after isometric exercise, till fatigue, was significantly more in men as compared to females. Significant gender differences in cardiovascular system responses occurred only upon performing isometric handgrip exercise.

The possible mechanism affecting sex difference in cardiovascular control is estrogen. 1)Estrogen attenuates cardiovascular responses to central reflex and to exercise pressor reflex hence significantly less increase in HR in women as compared to men on exercise (Table-4).[7] 2) The higher level of estrogen in women damp the reduction of cardiovagal tone to heart on exercise hence significantly small cardiovascular response(HR and SBP) in women to exercise.[7]Thus taken together the significantly small increase in HR and pressor response in women along with restrained reduction in vagal tone due to estrogen there is less sympathetic activity on exercise in women as compared to men. 3) The significantly more increase in DBP in men on exercise as compared to women suggest that the increase in peripheral resistance in men is more than that seen in women. According to the previous studies the concentration of catecholamines, epinephrine, norepinephrine and dopamine were found to be same in between genders at rest but it was found that the concentration of epinephrine is very high in men on beginning of exercise. Epinephrine acts on α-receptors at high concentration and causes vasoconstriction.[1] Thus all the above mechanisms explain the significant high increase in the rise of HR,

SBP, DBP and CW in the males as compared to females.

CONCLUSION:-

We conclude that isometric exercise of upperlimb leads to significant increase in cardiovascular parameters (heart rate, systolic blood pressure, diastolic blood pressure and cardiac work) of apparently healthy adults and the increase is significantly more in men as compared to women, although at rest the above parameters didnot show any significant difference between the genders.

The isometric exercise causes cardiovascular acceleration in both genders but the difference in the handgrip exercise (MVC, ET) and the difference in the cardiovascular response to isometric exercise is mainly due to hormonal differences.

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