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A Prospective Comparative Study Comparing Cardiovascular Reactivity in Obese Young Adult Male and Female Individuals.

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ABSTRACT

Background: Cardiovascular reactivity (CVR) is defined as increase in heart rate (tachycardia) and blood pressure (hypertension) due to stress by the activation of sympathetic nervous system. **Methods:** Students of 18-25 years of age of various courses at Teerthanker Mahaveer Medical College, Body Mass Index (BMI) > 18 kg/m2 and self-reported teetotallers was enrolled for the study. After recording the basal parameters, all subjects underwent various pressor stimuli and haemodynamic parameters were recorded accordingly. **Results:** All values dPulse was higher in female (0.87/min) than obese male (0.38/min), dSBP & dDBP was higher in Obese male (1.88mmHg &2.14mmHg) than obese female (1.16mmHg &1.09mmHg) with significant difference. HR showed insignificant difference by all stressors except just after 1min of Videogame. Blood pressure was higher in male subject's after1min/5min of stress with significant difference after 1min.of CPT/cycling/videogame. This is due to progesterone and due to their large musculature body. **Conclusion:** Obese male individual showing lower resting pulse rate but higher SBP &DBP than obese female subjects.CVR to stress, result was remains same dPulse was higher in female & the blood pressure was higher in obese male group with insignificant difference except 1min after 1min of VG.

Keywords: Cardiovascular Reactivity, Cardiovascular disease, Obesity.

INTRODUCTION

According to the survey of National Ambulatory Medical Care of United States 2002 by Woodwell[1], about 890 million patients of Cardiovascular disease (CVD) visited clinics of physicians and the prevalence of such visitors was significantly higher in metropolitan area as compared to non-metropolitan area. In 1990, a quarter of deaths were observed due to CVD among South Asian countries including India and its subcontinent (Nepal, Sri Lanka, Pakistan & Bangladesh).[2]

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Rapid urbanization and economic progress in India have changed the life style of the population, with promotion of poor eating habits, sedentary style of living, and increased mental and physical stress. Consequently, the incidence of life style diseases (obesity, hypertension, diabetes mellitus, hyperlipidemia, heart diseases etc) is increasing in direct proportion to the progress.[3]

The prevalence of obesity is due to combination of genetic susceptibility, consumption of fatty food and decreased requirement for physical activity in modern and economically stronger society. Secondary obesity occurs due in various diseases like hypothyroidism, Cushing syndrome etc. Obesity is also associated with multiple co-morbidities such as type 2 diabetes and hypertension, which may contribute to cardiovascular risk outcome.[4]

The genetic susceptibility for fatty food and decreased physical activity and these are the risk factors for future hypertension, inflammatory markers, glucose intolerance, obstructive sleep apnoea/ hypoventilation. Such complications of obesity & hypertension may be associated with increase in morbidity /mortality rate.[5]

Cardiovascular reactivity (CVR) is defined as increase in heart rate (tachycardia) and blood pressure (hypertension) due to stress by the activation of sympathetic nervous system.[6] Some studies advocate the pathophysiologic role of CVR

in the development of primary hypertension. However, role of genetic factors are rarely accounted in the studies relating to CVR and high blood pressure.

Extensive Medline search revealed limited literature comparing the cardiovascular reactivity in obese young adult male and female individuals. Therefore, we organised a prospective study to compare the cardiovascular responses in obese individuals of both the sexes against different pressor stimuli.

MATERIALS AND METHODS

After obtaining the approval of the study protocol from the Institutional Ethical Committee, we organised the study comparing the cardiovascular reactivity in obese young adult male and female individuals in Department of Physiology, Teerthankar Mahaveer Medical College, Moradabad to be done between July 2013 to June 2016.

Students of 18-25 years of age of various courses at Teerthanker Mahaveer Medical College, Body Mass Index (BMI) > 18 kg/m2 and self-reported teetotallers was enrolled for the study. Subjects frequently indulging in alcoholic drinks, Self-reported illness (chronic or acute) at the time of experiment, Resting heart rate greater than 90 beats per minute and resting blood pressure greater than 140/90 mm of Hg (to eliminate pre-experimental sympathetic stimulation of subjects), Physical disability like arthritis of the knee which may impair cycling, subject taking analgesics or antipyretics were excluded from the study.

The study involved enrolment of 250 students which were classified as follows:

Female
- Non-obese female
- Obese female

Male
- Non-obese male
- Obese male

Recording of Basal Parameters

Baseline parameters (weight, height, waist and hip circumference, resting pulse/blood pressure) of each subject were recorded at the beginning of experiment. Written informed consent was obtained only if the volunteer satisfied the inclusion and exclusion criteria. Pulse and blood pressure were recorded before and immediately after each experiment.

After recording the basal parameters, all subjects underwent various pressor stimuli and haemodynamic parameters were recorded accordingly.

Cold Pressor Task (CPT)

The subject was seated in a quiet room having a temperature of 23-25oC maintained by air conditioner kept at a comfortable position. The subject is instructed to immerse his/her non-dominant hand with palm down 5 cm above the base of container, containing cold water and ice separated with the help of aluminium separator of into a circulating water bath having a temperature maintained at 0-1^{o}C with the help of ice and water. Time of immersion (1 min) was recorded using a stop watch.

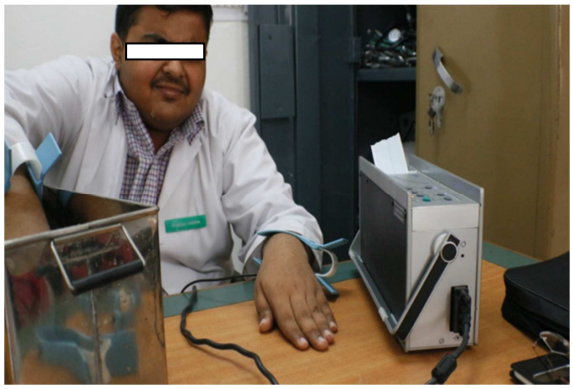

Figure 1: Subject performing CPT.

Isotonic Exercise (ergometer)

In a quiet room maintained at normal room temperature the study subject was seated and baseline heart rate and blood pressure were recorded. S/he was asked to sit on the ergo-meter and perform cycling for a period of 5 minutes. The tension developed was recorded as change in Heart rate and blood pressure immediately after 5 and 10 minutes after exercise.

Figure 2: Subject performing cycling.

Video Game (VG)

The subject was seated comfortably in front of personal computer. S/he was given the relevant instructions about the game, was assured that the result obtained did not matter, and was allowed a practice time of 1 minute. Baseline pulse and blood pressure were recorded after a two minute pause. After that the subject plays the game for 10 minutes and immediately after 10 and 15 minutes of game-play, heart rate and blood pressure were recorded again.

Figure 3: Subject playing NFS (videogame).

The blood pressure and ECG shall be recorded twice again at 5minute intervals during the recovery period. All ECG recordings shall be made using Lead 2.

Statistical Analysis

All statistical analyses were performed using Excel 2010 TM (Microsoft, Redmond, WA). Patient demographic characteristics were analysed using the t-test for independent groups. The results were presented in number, percentage, mean and standard deviation as appropriate. Parameters for CVR in terms of difference in Pulse rate, systolic/diastolic pressure were analysed using ANOVA and Student T –Test, which ever were applicable. A p-value of <0.05 (2-tailed) was considered statistically significant.

RESULTS

The study excluded 20 subjects (12 males and 8 females) as three males and two females had fever on the day of Cold pressor task, four males had high systolic pressure (more than 150 mm Hg) & five males and six females suffered injury during cycling. Therefore, the study involved 230 students out of which 140 & 90 were boys and girls respectively.

Table 1: Basal Parameters of Female and Male Individuals.

	Male subjects (n= 140)			Female subjects (n =90)			
	Min	**Max.**	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**	**P Value**
Age (years)	18	25	21.27 ± 0.84	18	25	21.12 ± 0.73	>0.05
BMI (kg/m^2)	19.37	36.51	27.52 ± 3.85	17.5	24	24.84 ± 5.04	>0.05
Pulse (/min.)	69	84	75.52 ± 5.61	68	85	76.25 ± 4.81	>0.05
SBP (mmHg)	106	134	117.6 ± 7.33	102	126	113.3 ± 5.33	<0.001
DBP (mmHg)	62	90	72.75 ± 6.91	60	80	70.2 ± 4.49	<0.001

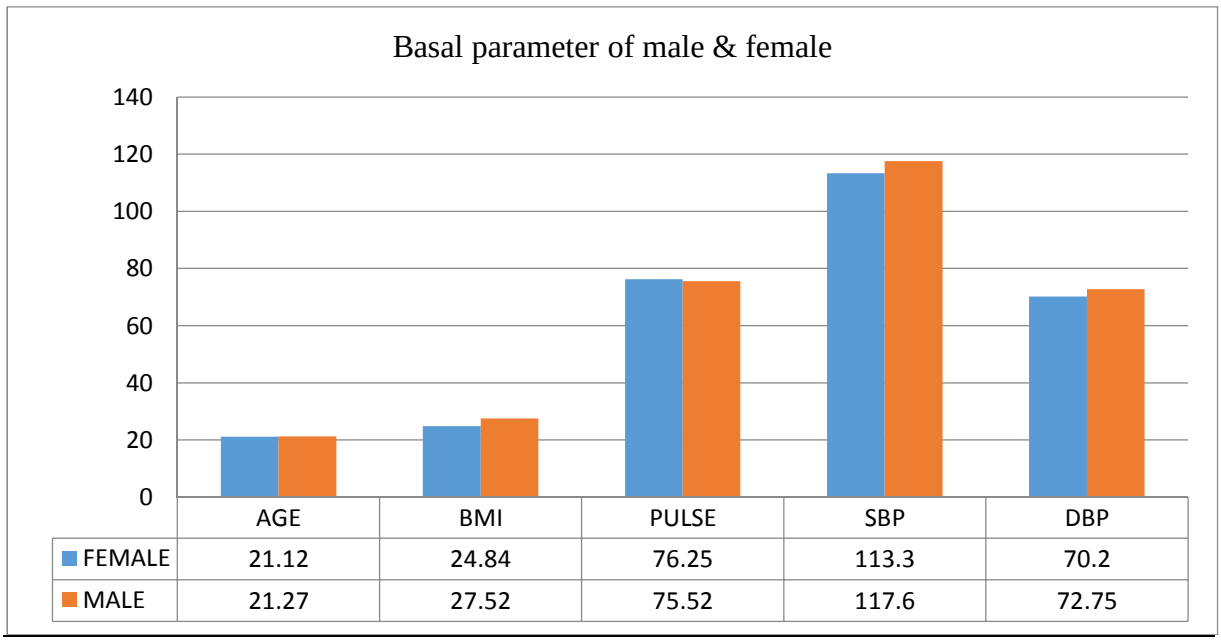

Figure 11: Demographic & basal parameter of male &female individuals.

On comparing the demographic characteristics both the groups were found to be comparable between them. The Systolic blood pressure of boys were 117.6 ± 7.33 mm Hg while of girls were 113.3 ± 5.33 mm Hg ($p<0.001$). Similar statistical significance was observed on comparing Diastolic blood pressure between boys and girls. However, comparable results were observed on comparing pulse rate between both the sexes. [Table 1, Figure 1].

A. Cardiovascular reactivity to cold pressor task

Table 2(a) compares the cardiovascular reactivity after 1min. of CPT in male & female group. The dPulse values was insignificant different but dSBP & dDBP was higher in male (2.64 &2.34) than female (1.95 & 1.84) with significant difference [Figure 2(a)]. The dPulse & dSBP values was insignificant different but dDBP was higher in male (0.68) than female (0.35) with significant difference [Table 2(a), Figure 2(b)].

B. Cardiovascular reactivity to Cycling

Table 3 (a) & 3 (b) compares the CVR to cycling among male & female subjects by Student t-test. Only the dPulse values showed a statistically insignificant difference between the both. But dSBP & dDBP was higher in male (2.64 &2.54) than female (1.75 & 1.88) with significant difference [Figure 3(a)]. Reactivity after 5min. of Cycling in male & female group. The dPulse & dSBP & dDBP values was insignificant different but dPulse was higher in female group (0.46) than male (0.25), dSBP & dDBP was higher in male (0.6 &0.64) than female (0.42 & 0.4) with insignificant difference [Figure 3(b)].

C. Cardiovascular reactivity to Videogame

Table 4 (a) & 4 (b) compares the CVR to Videogame after 1min, among male & female subjects by Student t-test. All values dPulse, dSBP & dDBP were higher in male (0.73/min, 1.22 mm Hg &1.3 mm Hg) than female (0.36/min, 73 mm Hg & 0.57 mm Hg) with significant difference [Figure 4(a)]. Reactivity after 5min. of Videogame in male & female group. The dPulse&dSBP&dDBP values shows insignificant different but dPulse&dDBP was slightly higher in female group (0.18/min, 0.24mmHg) than male (0.17/min&0.22mmHg) but dSBP was higher in male (0.25mmHg) than female (0.2mmHg) with insignificant difference [Figure 4(b)].

Table 2 (a): Comparison of Cardiovascular Reactivity in Male & Female Individual after 1min.Of CPT.

Cardiovascular Reactivity	Boys (n=140)	Girls (n=90)	p-Value
	Mean± SD	Mean± SD	
dHR(/ min)	1.57±1.32	1.73±1.22	>0.05
dSBP (mmHg)	2.64±1.29	1.95±2.13	<0.001
dDBP (mmHg)	2.34±1.01	1.84±1.40	<0.001

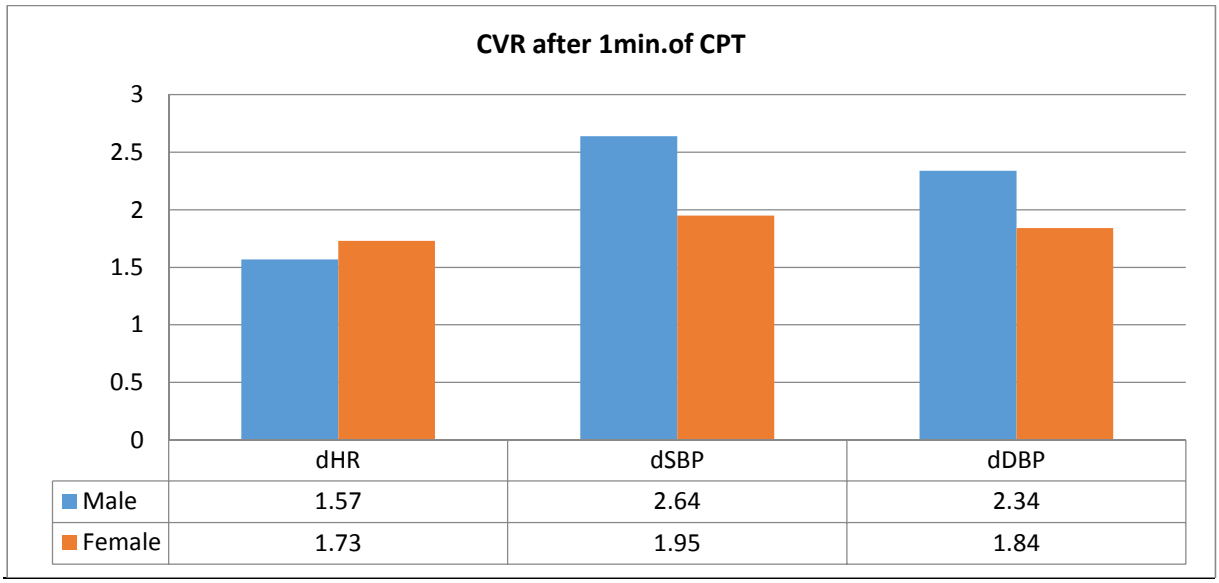

Figure 2 (a): Male & Female Individual after 1min.Of CPT.

Table 2(b): Comparison of Cardiovascular Reactivity in male & female individual after 5 min. of CPT.

Cardiovascular Reactivity	Boys(n=140)	Girls (n=90)	p-Value
	Mean± SD	Mean± SD	
dHR(/ min)	0.44±0.75	0.46±0.88	>0.05
dSBP (mmHg)	0.6±0.95	0.64±1.36	>0.05
dDBP (mmHg)	0.68±1.01	0.35±0.87	<0.05

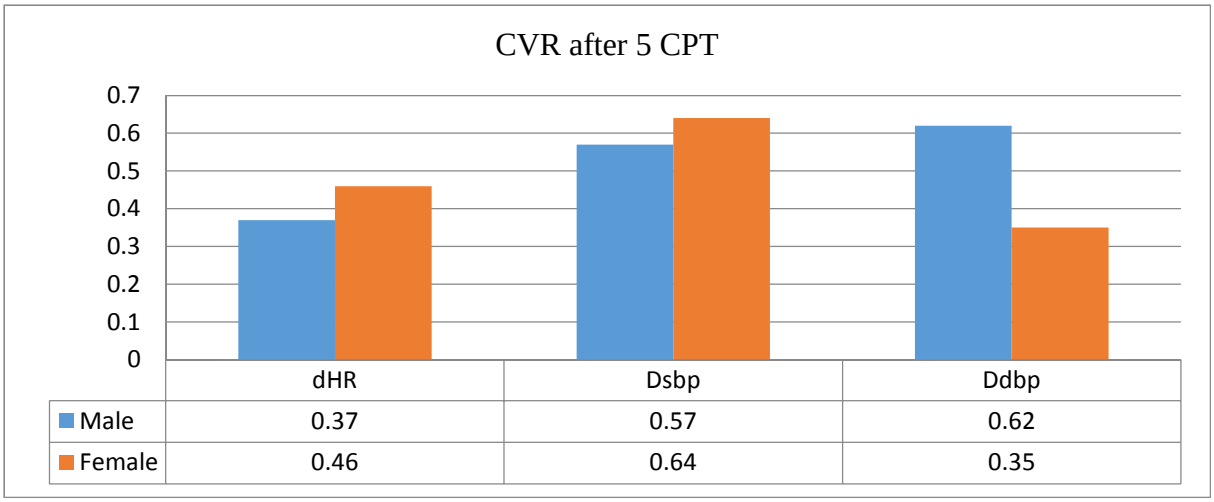

Figure 2 (b): Male & female after 5min.of CPT

Table 3 (a): Comparison of Cardiovascular Reactivity in male & female individual after 1min.of Cycling.

Cardiovascular Reactivity	Boys(n=140) Mean±SD	Girls Mean±SD	p-Value
dHR(/ min)	1.55±1.19	1.51±1.23	>0.05
dSBP (mmHg)	2.64±1.48	1.75±1.60	< 0.001
dDBP (mmHg)	2.54±1.31	1.88±1.53	< 0.001

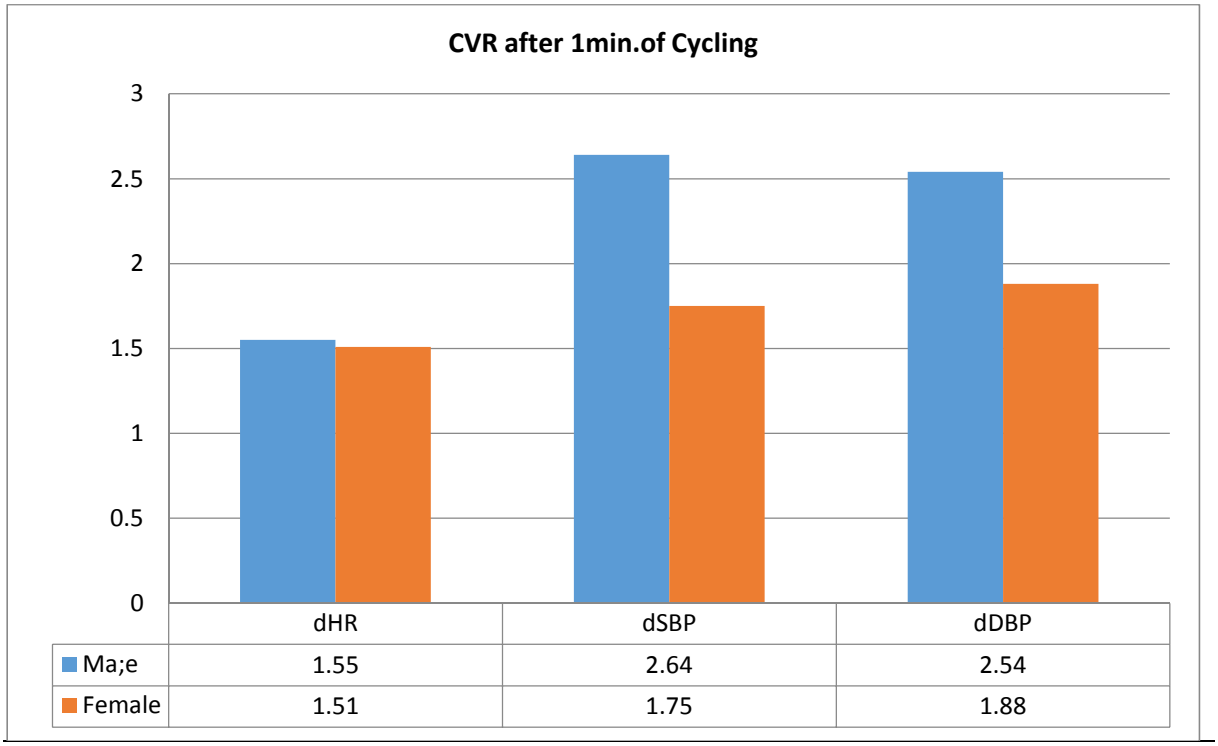

Figure 3 (a): male & female individual after 1min.of Cycling.

Table 3 (b): Comparison of Cardiovascular Reactivity in Male & Female Individual after 5 Min. of Cycling.

Cardiovascular Reactivity	Boys(n=140) Mean ± SD	Girls (n=90) Mean± SD	p-Value
dHR(/ min)	0.25 ± 1.05	0.46±0.68	>0.05
dSBP (mmHg)	0.6±1.0	0.42±0.91	>0.05
dDBP (mmHg)	0.64±1.10	0.4±0.85	>0.05

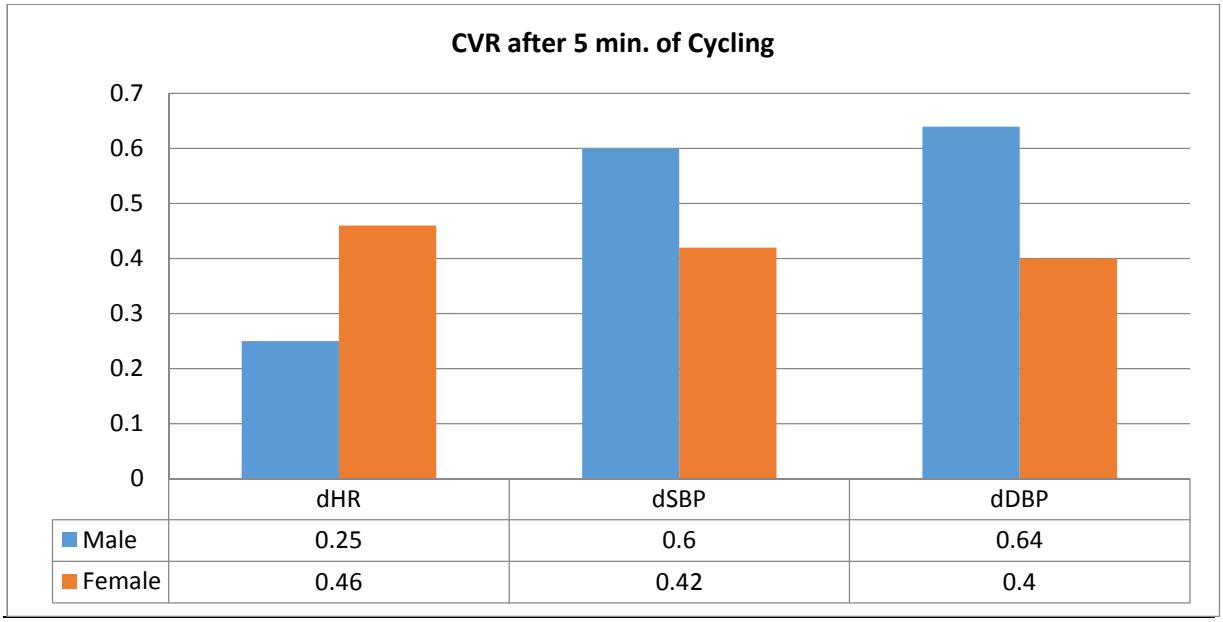

Figure 3 (b): Male & female individuals after 5min. of Cycling

Table 4 (a): Comparison of Cardiovascular Reactivity in Male & Female Individual after 1min. of Videogame.

Cardiovascular Reactivity	Boys (N=140) Mean± SD	Girls (N=90) Mean± SD	p-Value
dHR(/ min)	0.73±0.71	0.36±0.60	<0.001
dSBP (mmHg)	1.22±1.14	0.73±1.00	<0.001
dDBP (mmHg)	1.3±1.35	0.57±0.90	<0.001

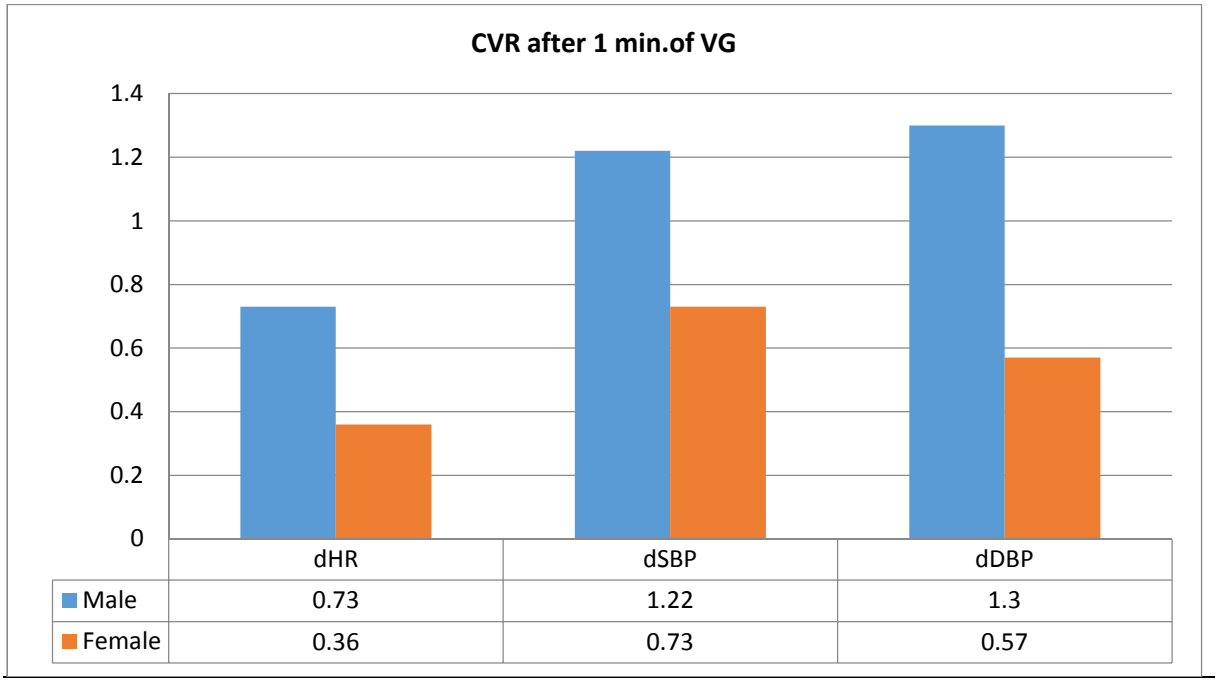

Figure 4 (a)2: Male & Female Individual after 1min. of VG.

Table 4(b): Comparison of Cardiovascular Reactivity in Male & Female Individual after 5 Min. of Videogame.

Cardiovascular Reactivity	Boys (N=140) Mean±SD	Girls (N=90) Mean±SD	p-Value
d HR(/ min)	0.17±0.46	0.18±0.49	>0.05
d SBP (mmHg)	0.25±0.75	0.2±0.73	> 0.05
d DBP(mmHg)	0.22±0.93	0.24±0.83	>0.05

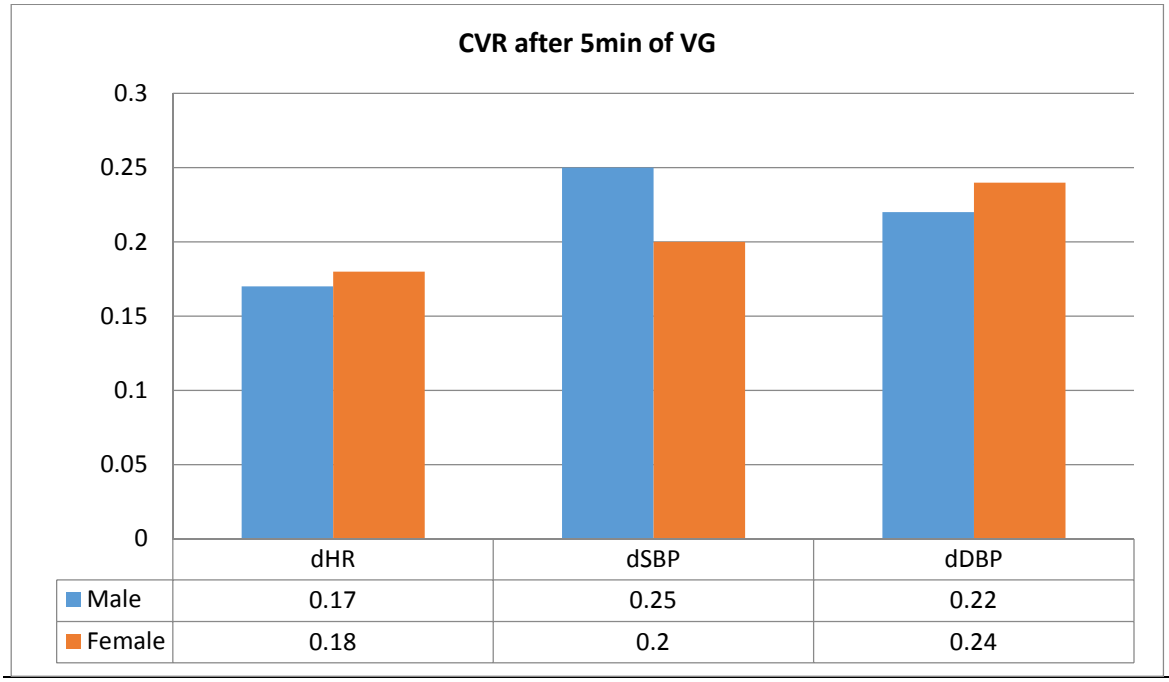

Figure 4(b): Male & female individuals after 5min. of VG

Table 5: Basal Parameters of Obese Male and Obese Female Individuals

Obese female subjects had slightly higher pulse rate (mean: 76.00/min) compared to the obese male subjects (mean: 74.94/min) with p value >0.05. Obese male subjects had higher systolic & diastolic blood pressure (mean: 118.59mmHg & 74.14 mmHg) than Obese female subjects (mean: 113.09mmHg & 70.15 mmHg with significant difference [Table 5, Figure 5].

A. Cardiovascular reactivity to cold pressor task

Table 6 (a) & 6 (b) compares the cardiovascular reactivity after 1min. of CPT. The dPulse was slightly higher in obese female(2.58/min) than obese male (2.31/min) dSBP & dDBP was higher in obese male (2.92mmHg &2.74 mmHg) than obese female (2.90mmHg & 2.32mmHg)with significant difference [Figure 6 (a)]. Reactivity after 5min. of CPT, The dPulse was higher in obese female (0.96/min) than obese male (0.92/min) with highly significant difference but dSBP was higher in obese female (1.35 mmHg) than obese male (0.96 mmHg) & dDBP was higher in male subjects (1.07 mmHg) than female(0.58 mmHg)showing significant difference [Figure 6 (b)].

B. Cardiovascular reactivity to Cycling

Table 7 (a) &7 (b) compares the cardiovascular reactivity after 1min. of Cycling. The dPulse, was higher in obese female (2.41/min) than male (2.12/ min) & Dsbp & dDBP was higher in obese male (3.14mmHg & 2.92mmHg) than obese female (2.96mmHg & 2.38mmHg)with insignificant difference [Figure 7 (a)]. Reactivity after 5min. of Cycling, The dPulse was higher in female (0.74/min) than male (0.57) dSBP & dDBP was higher in obese male (1.25mmHg &1.0 mmHg) than obese female (0.16mmHg &0.83mmHg)with insignificant difference [Figure 7 (b)].

C. Cardiovascular reactivity to Videogame

Table 8 (a) & 8 (b) All values dPulse was higher in female (0.87/min) than obese male (0.38/min), dSBP & dDBP was higher in Obese male (1.88mmHg &2.14mmHg) than obese female (1.16mmHg &1.09mmHg) with significant difference [Figure 8 (a)]. Reactivity after 5min. of Videogame, the dPulse was slightly higher in female (0.48/mmHg) than male (0.38/min) and dSBP values was higher in Male (0.62mmHg) than Female (0.51mmHg) shows insignificant different but dDBP was higher in Obese female group (0.70mmHg) than obese male (0.55mmHg) with significant difference [Figure 8 (b)].

Table 5: Comparison of Basal Parameters in Obese Male and Female Individuals.

Cardiovascular Reactivity	Obese male(n=54)	Obese female(n=31)	p-Value
	Mean±SD	Mean±SD	
Pulse(/ min)	74.94±5.77	76.51±4.97	>0.05
SBP(mmHg)	118.59±7.87	113.09±5.88	<0.001
DBP(mmHg)	74.14±7.54	70.25±4.34	<0.05

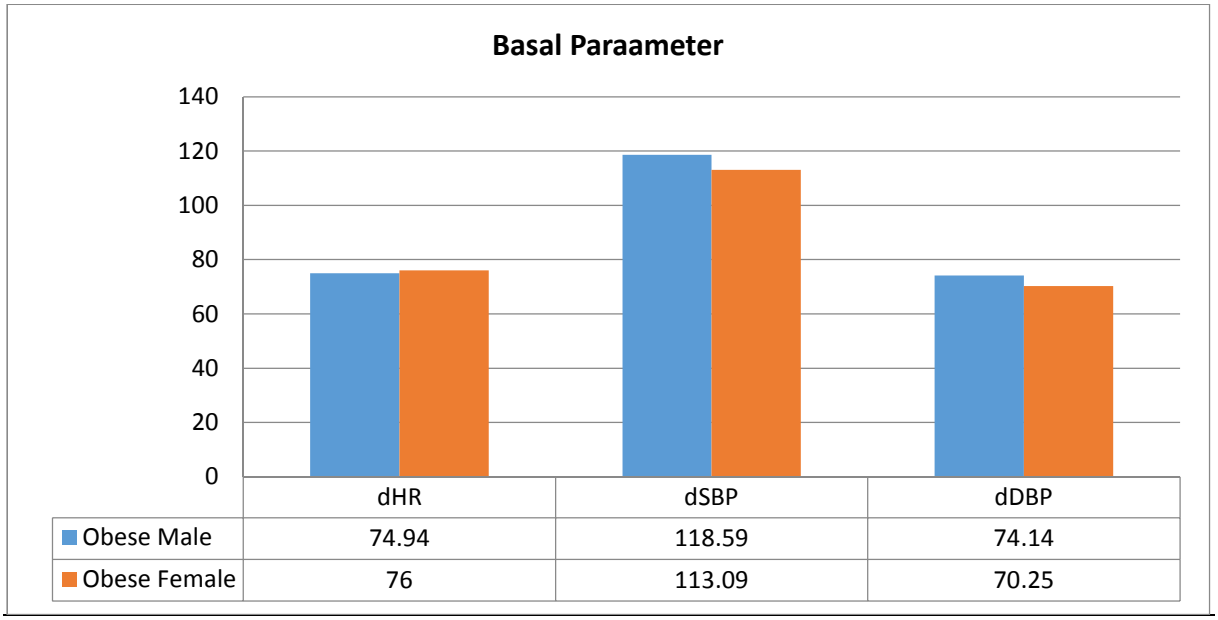

Figure 5: Basal Parameters in Obese Male and Female Individuals

Table 6 (a): Comparison of Cardiovascular Reactivity in Obese Male and Female Individuals after 1min. CPT.

Cardiovascular Reactivity	Obese Male(n=54)	Obese female(n=31)	
	Mean±SD	Mean±SD	P-value
dPulse(/ min)	2.31±1.22	2.58±1.05	>0.05
dSBP(mmHg)	2.92±1.14	2.90±1.35	> 0.05
dDBP(mmHg)	2.74±0.97	2.32±1.16	>0.05

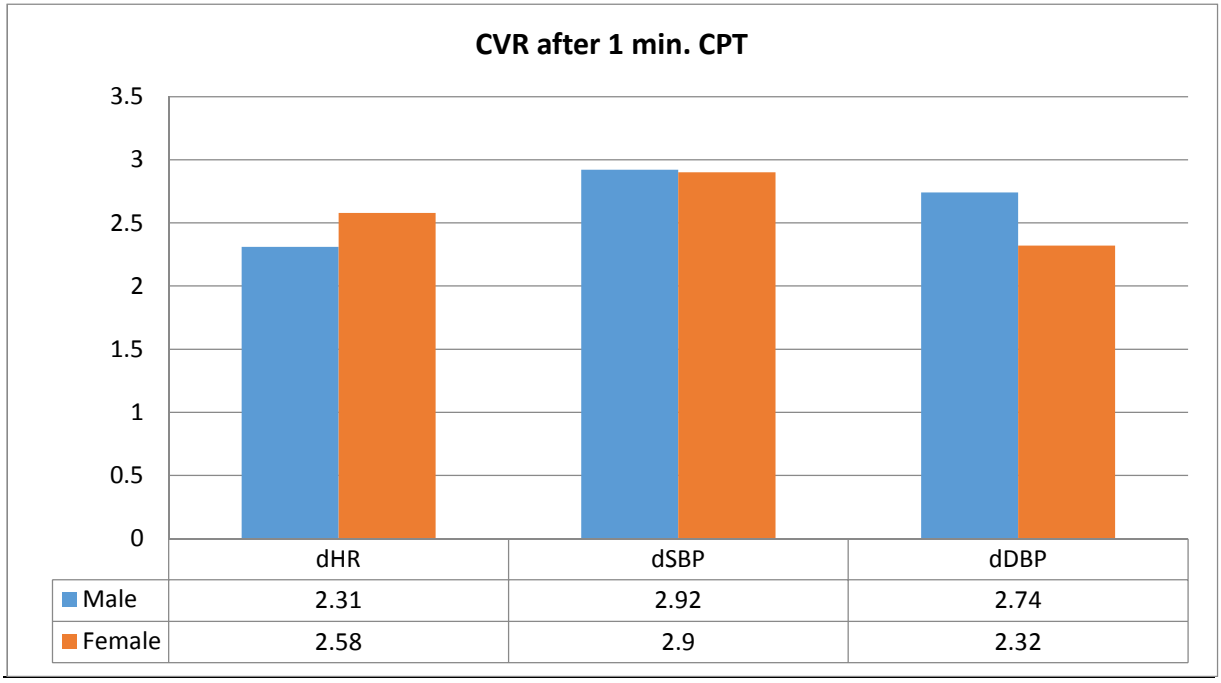

Figure 6 (a): Obese Male and Female Individuals after 1min. CPT.

Table 6 (b): Comparison of Cardiovascular Reactivity in Obese Male and Female Individuals after 5min. of CPT

Cardiovascular Reactivity	Obese Male(n=54)	Obese female(n=31)	
	Mean±SD	Mean±SD	P-value
dPulse(/ min)	0.92±0.88	0.96±1.13	>0.05
dSBP (mmHg)	0.96±1.08	1.35±0.95	>0 .05
dDBP (mmHg)	1.07±1.07	0.58±1.05	< 0.05

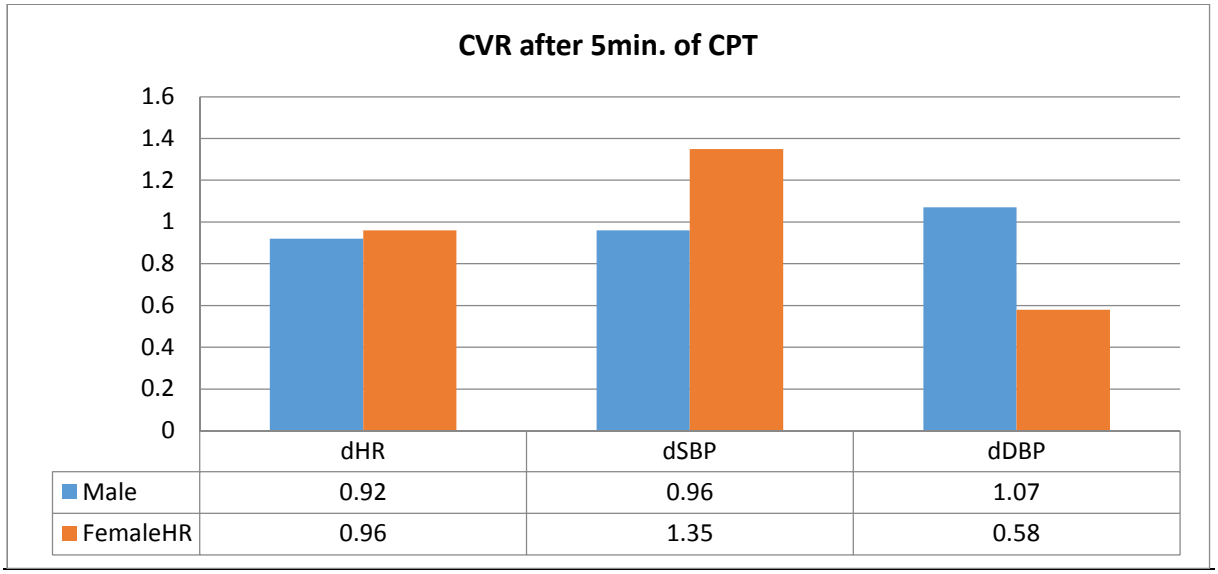

Figure 6 (b): Obese Male and Female Individuals after 5min. of CPT

Table 7 (a): Comparison of Cardiovascular Reactivity in Obese Male and Obese Female Individuals after 1min. of Cycling

Cardiovascular Reactivity	Obese Male(n=54)	Obese female(n=31)	
	Mean±SD	Mean±SD	P-value
dPulse(/ min)	2.12±1.16	2.41±1.23	>0.05
dSBP (mmHg)	3.14±1.37	2.96±1.70	>0.05
dDBP(mmHg)	2.92±1.14	2.38±1.66	> 0.05

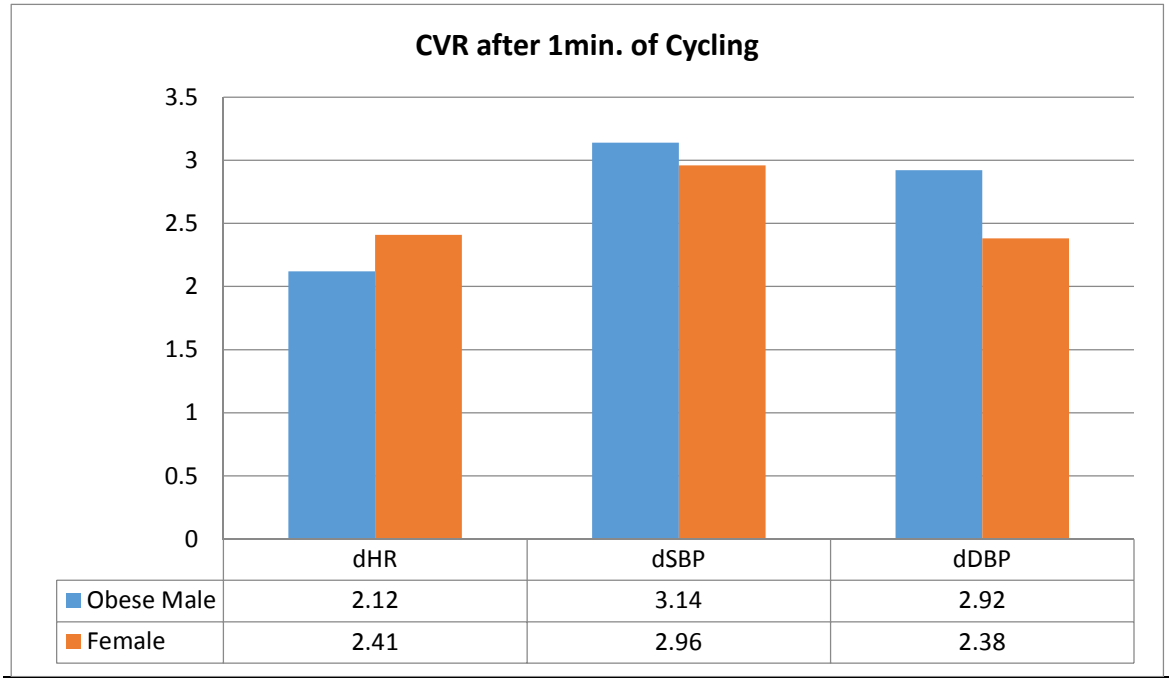

Figure 7 (a): Obese Male and Obese Female Individuals after 1min. of Cycling

Table 7 (b): Comparison of Cardiovascular Reactivity in Obese Male and Female Individuals after 5 Min. of Cycling.

Cardiovascular Reactivity	Obese Male(n=54)	Obese female(31)	
	Mean±SD	Mean±SD	P-value
dPulse(/ min)	0.57±1.12	0.74±0.77	<0.05
dSBP(mmHg)	1.25±1.04	1.16±1.12	>0.05
dDBP (mmHg)	1.0±1.08	0.83±1.00	> 0.05

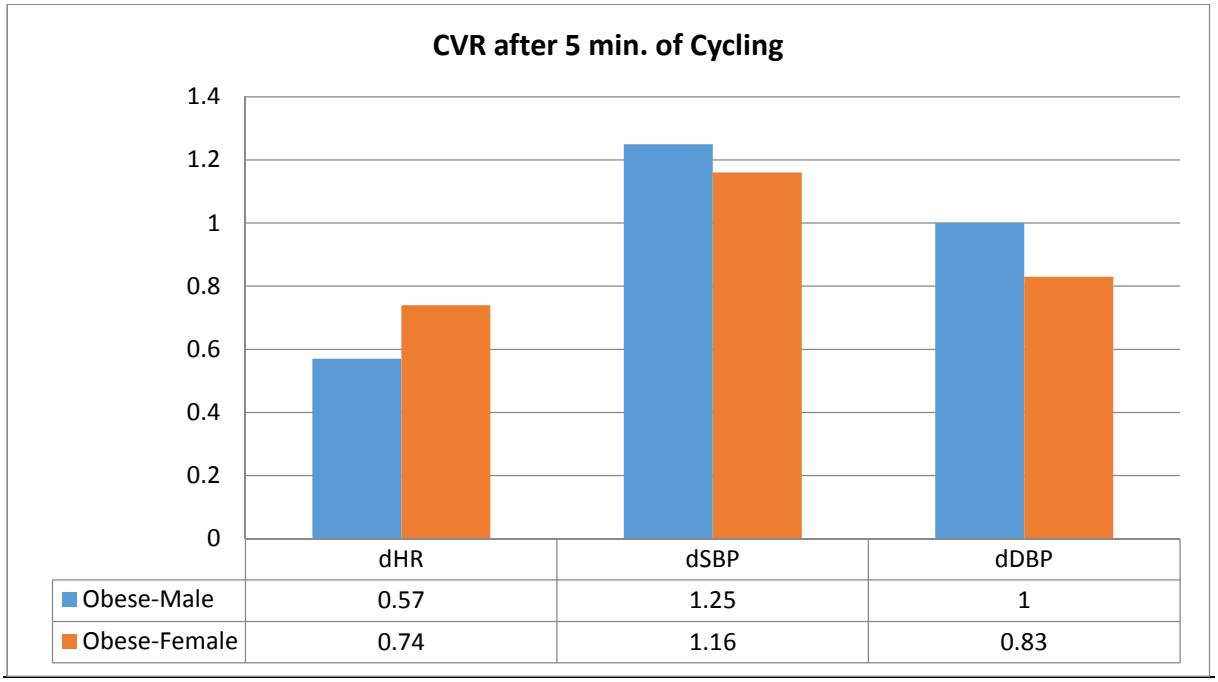

Figure 7 (b): Obese Male and Female Individuals after 5 Min. of Cycling.

Table 8 (a): Comparison of Cardiovascular Reactivity in Obese Male and Female Individuals after 1 Min. of Videogame

Cardiovascular Reactivity	Obese Male(n=54)	Obese female(n=31)	
	Mean±SD	Mean±SD	P-value
dPulse(/ min)	1.22±0.71	0.87±0.56	<0.05
dSBP (mmHg)	1.88±0.90	1.16±1.12	< 0.05
dDBP(mmHg)	2.14±1.21	1.09±1.00	< 0.05

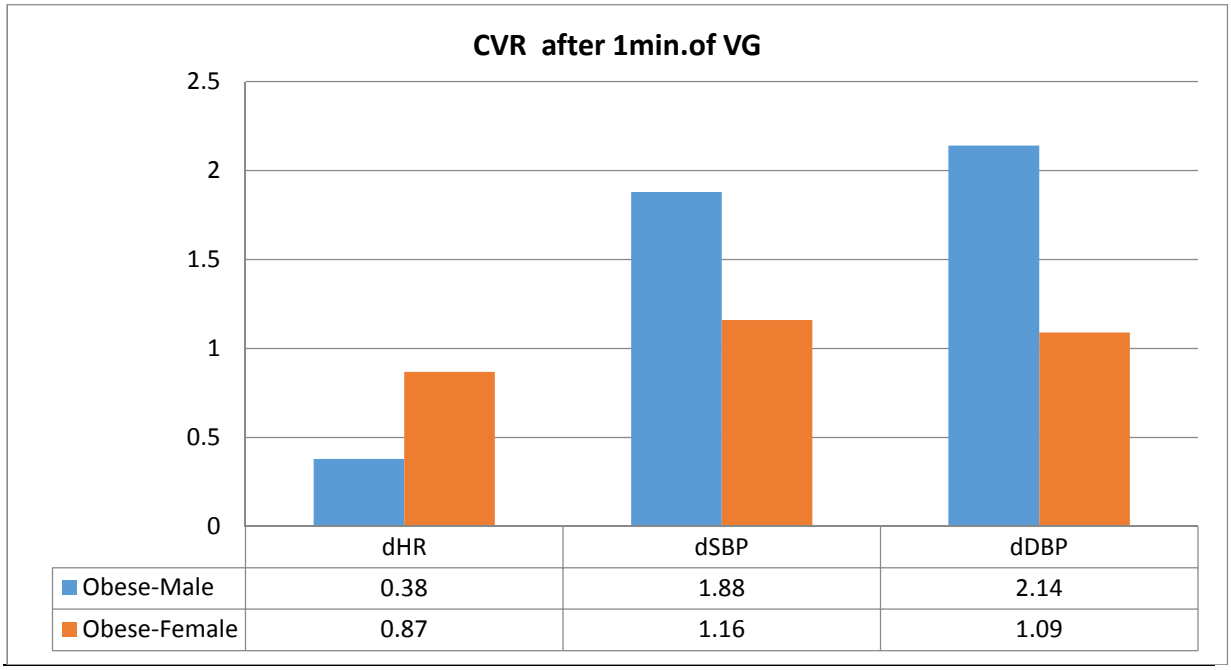

Figure 8 (a): Male and Female Individuals after 1 Min. of Videogame

Table 8 (b): Comparison of Cardiovascular Reactivity in Obese Male and Female Individuals after 5 Min. of Videogame

Cardiovascular Reactivity	Obese Male(n=54)	Obese female(n=31)	
	Mean±SD	Mean±SD	P-value
dPulse(/ min)	0.38±0.55	0.48±0.59	>0.05
dSBP(mmHg)	0.62±0.93	0.51±0.88	> 0.05
dDBP(mmHg)	0.55±1.25	0.70±1.10	> 0.05

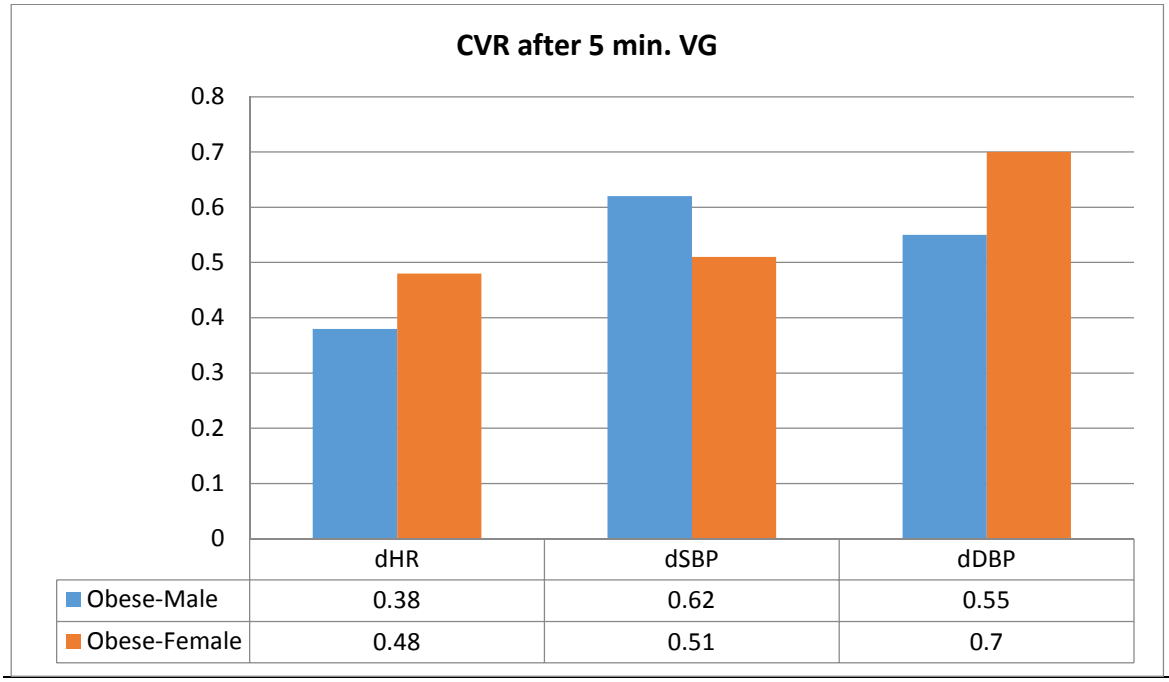

Figure 8 (b): Obese Male and Female Individuals after 5 Min. of Videogame

DISCUSSION

Female and male subjects of 18 to 25 years of age with normal & more than normal body mass indices (BMI) were selected for this study. Rajalakshmi et al. [7] used different indices in their research work and suggested that BMI is the better predictor for systolic as well as diastolic blood pressure. A body mass index of 18.5- 24.99 Kg/m2 considered normal. Since BMI differing vastly from the normal range can affect blood pressure, and consequently the results, Subjects with BMI <18 (underweight) were excluded from this study.

Table 1 compares the basal parameters with CVR to different stressors of all females with respective values from male subjects. The resting pulse rate was higher in females (mean: 76.25/min), compared to the male subjects (mean: 75.52/min) but not significant & resting blood pressure was higher in the males (mean SBP: 117.6 mmHg; mean DBP: 72.75mmHg) compared to the values obtained from the female subjects (mean SBP: 113.3 mmHg; mean DBP: 70.2 mmHg). This difference in blood pressure was statistically significant. According to Nicklas TA, et, al.[3] the female hormones estrogen is responsible for this difference in pulse and blood pressure values between female and male subjects. It accelerates the heart rate and lowers the blood pressure in females of the reproductive age group but higher blood pressure in male due to androgen hormone & musculature structure. Mathews et al[8] have reported the resting blood pressure values in black and white subjects of both sexes.

The much higher values of resting blood pressure observed in Indian subjects. The situation is more alarming keeping in view that the subjected selected in this study were younger and had normal BMI, pulse rate, and blood pressure. We included the blood pressure data from all the volunteers reserved for this study; the values of resting blood pressure would have been much higher. This comparison highlights the urgent need to educate the common young people about the dangers of hypertension, as well as about the risk factors leading to hypertension.

The resting pulse rate was higher in obese female (mean: 76.00/min), compared to obese male subjects (mean: 74.94/min). The resting blood pressure was higher in obese males (mean SBP: 118.59 mmHg; mean DBP: 74.14mmHg) compared to the values obtained from the obese female subjects (mean SBP: 113.09 mmHg; mean DBP: 70.15 mmHg). These differences in pulse and blood pressure were showing statistically significant difference. This difference is due to hormone androgen which is the excitatory to erythropoiesis in male but estrogen is the inhibitory hormone to erythropoiesis in females. Cardiovascular reactivity to stress was monitored in terms of increase in pulse rate (dPulse), systolic (dSBP) & diastolic blood pressure (dDBP) observed upon subjection to stress. All three stresses produced larger increases in CVR in male subjects with female subjects

Difference in mean pulse rate was higher in females compared to the male subjects showing insignificant difference. Blood pressure was higher in the males compared to the values obtained from the female subjects with significant difference in dSBP & dDBP after 1min & after 5min after CPT only dDBP shows significant difference.

Difference in mean pulse rate & blood pressure was higher in the males compared to the values obtained

from the female subjects with significant difference in dSBP & dDBP after 1min & after 5min of Cycling heart rate was higher in female than male but SBP 7 DBP was higher in male but with insignificant difference. Highest mean value was showed by Cycling.

Difference in mean pulse rate, dSBP & dDBP was lower in females compared to the male subjects showing significant difference. Blood pressure was higher in the males compared to the values obtained from the female subjects only after 1min of Videogame not after 5min after Videogame. Videogame showed lowest CVR in male & female subjects.

Matthews KA, Katholi CR et al.[8] told that CVD had positive association with stress response on the risk for hypertension.Silvanea M,et al. [9] Timio M, et al. [10] Cobb S et al. [11] Schwartz JE E,et al. [12] Poulter N,et al. [13] & Kaufman JS, et al [14] observed that acute stress is usually increase in blood pressure for short period but chronic stress is responsible for sustained hypertension due to weakening of the autonomic nervous system and leads to rise in the blood pressure. The increase of blood pressure/heart rate depends on the type of stress (acute/chronic).

Krant DS. [15] also shows positive relation between stress & pre hypertension and other CVD due to release of epinephrine, norepinephrine and catecholamine which increases force and rate of contraction of heart vascular changes.

CONCLUSION

1. All male subjects had lower resting pulse rate and higher resting blood pressure in comparison to female subject. This can be attributed to the female reproductive hormone oestrogen. HR showed insignificant difference by all stressors except just after 1min of Videogame. Blood pressure was higher in male subject's after1min/5min of stress with significant difference after 1min.of CPT/cycling/videogame. This is due to progesterone and due to their large musculature body.
2. Obese male individual showing lower resting pulse rate but higher SBP &DBP than obese female subjects.CVR to stress, result was remains same dPulse was higher in female & the blood pressure was higher in obese male group with insignificant difference except 1min after 1min of VG.
3. Obesity is known to be a risk factor for HT; therefore CVR in underweight, normal, and obese subjects may be compared to correlate the genetic influence with obesity.
4. Female hormones are known to affect the heart rate and blood pressure. Thus CVR to stress may be compared in the different phases of the menstrual cycle.

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