Introduction:

No matter what our age one should exercise daily. Healthy diet and regular exercise improve health as well as lower health care costs. Regular physical activity is vital for good physical and mental health.

Young females benefit a lot from physical activity. Exercise build and maintain healthy bones, muscles and joints. It helps to reduce risk for many chronic diseases like hypertension, diabetes mellitus etc. Participation in athletic activity improves physical fitness, coordination and self discipline. Sport exposure encourages the development of motor skills, social skills, leadership and gives them opportunity to learn teamwork. Females who participate in sports have higher self-esteem and pride in themselves. In developing countries like India females are not that much exposed to the sports activity in females.

VO₂ max is a maximum rate of oxygen consumption as measured during incremental Exercise [1]. It is also called as Maximum Oxygen Consumption /Maximal Oxygen Uptake/ Peak Oxygen Uptake/ VO₂ max or aerobic capacity. Maximal oxygen uptake reflects the aerobic physical fitness of the individual. It is an important determinant of the endurance capacity during prolonged sub-maximal exercise. VO₂ max is expressed as an absolute rate liters of oxygen per kg of body mass per minute ml/(kg.min).VO₂ max is often used to compare the performance of endurance in sports athletes. [2]

Rate pressure product(RPP) is the product of pulse rate and systolic blood pressure. It is an index of myocardial oxygen consumption. [3] Rate pressure product is also called as cardiovascular product or double product. It is used in cardiology and exercise physiology to determine myocardial oxygen consumption. Myocardial oxygen consumption correlate highly with the work of the heart. Because of essentially aerobic metabolism of myocardium ,changes in MVO₂ correlate highly with the work of the heart. Thus Rate pressure product is used to measure workload on the heart to provide adequate blood supply to the myocardium during exercise in athletes. Rate pressure product increases with increased workload on the heart and reflects hemodynamic stress.[4] RPP is especially valuable and does not require expensive instrument or invasive monitoring and therefore applicable in intensive care units and trauma care units.

The present study investigated the rate pressure product and VO₂ max in female athletes by comparing them with non-athletes.

Aims and Objectives- 

1) To determine the VO₂ max levels and Rate-pressure product levels in female athletes.

2) To compare the VO₂ max levels and RPP in female athletes with females having sedentary life-style.

Material and Methods-

This observational study was carried out in 50 females of age group between 18-22 yrs in Department of Physiology, Government Medical College, Aurangabad. Each female signed on informed consent before participating in the study. All the procedures and protocols were reviewed by the institutional ethical committee. Study group comprises 25 female athletes (n=25). They were selected from Police Training Institute ,Cidco, Aurangabad . All the subjects were either athletes or non-athletes. The VO₂ max levels and Rate-pressure product levels were compared between study group and controls.

Results: The VO₂ max levels were statistically higher in female athletes than non-athletes. The RPP levels were lower in female athletes as compared to controls. The decrease was statistically significant.

Conclusion: The present study showed VO₂ max levels more and RPP levels low in female athletes. Physical inactivity is seen among medical students due to sedentary lifestyle which may lead to many health problems. Our study concluded that regular exercise improves the physical fitness.
in the study group were doing minimum 3 hrs exercise (like running, cycling, jogging etc.) daily since 2 years. Control group comprises 25 females (n=25) of same age group having sedentary lifestyle. They were not doing any type of exercise at all.

A detailed history was taken including personal history, past history and menstrual history. The study was carried out during proliferative phase of menstrual cycle of all the females. General and detailed systemic examination was done of all subjects. The subjects having cardio-respiratory and neurological disorders were excluded from the study. BMI of the subjects were measured in all the participants.

BMI = Wt in Kg / (Ht in m)^2

Procedure for VO₂ max
All measurements were performed in a quiet and air-conditioned room. (24°C) The VO₂ max was determined 3 hrs. after meal. The VO₂ max was determined by using Queen’s College Step Test.[2] All the subjects were asked to warm up for 5-7 min (like brisk walking, stretching etc.) A wooden stepping bench of 16½ inch was used along with metronome and stopwatch.

Metronome was set at the rate of 24 steps per min. The subjects were given a brief demonstration of the procedure. The subjects were asked to perform up and down stepping cycle for 3 min. After completion of test, pulse rate was measured for 15 sec. in standing position. This recovery pulse rate is converted to beats per minute.

Following equation is used to measure VO₂ max in females
VO₂ max (ml/kg/min) = 65.81 - (0.1847 * step test PR/min) [2]

Procedure for Rate-Pressure Product
Rate-pressure product is the product of heart rate and systolic blood pressure. RPP = Heart rate x Systolic blood pressure.[3]

Resting pulse rate was measured by examining radial pulse. We have taken three successive readings and then mean of it.

All the subjects were briefed about the procedure for recording of the blood pressure. After relaxation for 10 min. the resting blood pressure was recorded in the sitting position using a mercury sphygmomanometer and stethoscope by auscultatory method. Again we have taken three successive readings of blood pressure and then mean of it.

Rate pressure product was calculated as a product of heart rate and systolic blood pressure.[3]

Rate pressure product (RPP) = Systolic blood pressure x Heart rate

(mmol Hg x bpm) / (mm of Hg x (bpm))

Any total value of RPP greater than 10,000 indicates increased risk for heart diseases.[4]

The statistical analysis of this study was done by applying (unpaired t test) by using Microsoft Excel 2007 Software. P value of 0.05 was taken as significant.

Results-
In the present study female athletes showed statistically significant increase in VO₂ max levels as compared to non-athletes in female athletes as compared to controls. The mean VO₂ max (ml/kg/min) levels in female athletes was 39.35 ±2.78. The mean VO₂ max (ml/kg/min) in females with sedentary life style was 24.02 ± 3.69. (Table no.1)

The levels of rate pressure product in female athletes were significantly lower in athletes than non-athletes. The mean value of RPP in female athletes was 7921.28±649.14 and the mean value of RPP in control group was 8652.50±810.69 (Table no.2)

Discussion-
In the present study female athletes showed significant increase in VO₂ max in female athletes as compared to controls.

The training of athletes include different exercises like running, jogging and stretching exercises regularly since 2 years. All these flexibility exercises such as stretching improve range of muscle movements and joints. Aerobic processes are the main source of energy for muscles.[5] VO₂ max is the quantitative statement of individual’s capacity for aerobic transfer. In athletes high VO₂ max may be attributed to specific character of their training.

High VO₂ max yields more energy and better athletic activity. Factors affecting VO₂ max are age, gender, heredity, body composition, training state and exercise mode. Physiologically VO₂ max is the intensity of an individual to increase metabolic processes with the requirements of increased physical efforts.[6] This results due to transformation of chemical energy into mechanical mechanical one. [7,8] VO₂ max is the measure of aerobic capacity and is determined as international standard of physical capacity. [7,8] It is expressed as liters of O₂/min or ml of O₂ per kg of body wt/min.

Training increases VO₂ max by increasing the cardiac output secondary to high stroke volume. [9] Training also increases Arterio-venous oxygen difference. [9] Physiological training increases VO₂ max 50% by increasing stroke volume and 50% increase is due to increased extraction of oxygen by working muscles which is reflected in an increased arterio-venous difference. The intense aerobic endurance training can induce considerable enlargement of all muscles with a change in cardiac configuration [9]

Training increases density of capillaries in skeletal muscles. This increased capacity to irrigate the muscles with blood lead to increased vascularization. [10] Training also results in increase in no. of mitochondria with increased capacity to generate ATP aerobically by oxidative phosphorylation [11] VO₂ max increases cardio-respiratory fitness and it is the predictor of success in endurance events.[2]

Results of our study are found to be consistent with studies of Hermansen and Andersen [10] Amanda L. et al.[11]. They found significant increase in VO₂ max in trained group as compared to untrained group. Amanda L. et al [11] reviewed VO₂ max and suggested physical training for improving VO₂ max.

In this study Rate pressure product levels of study subjects were decreased as compared to controls. RPP is the product of heart rate and systolic blood pressure, is a good
estimate of myocardial work or internal work done and is proportional to myocardial oxygen consumption.[12]

There was significant reduction in RPP after the training, indicating that the left ventricle is performing less work and hence has O₂ consumption at rest. Besides training-induced decrease in heart rate and systolic blood pressure, the reduction in double product may be due in part to training induction in total peripheral resistance, and hence reduced afterload. These findings suggest that low intensity exercise training decreases RPP and is consistent with previous findings.[13]

Results of our study are also consistent with Sea and Chase et al. They showed that training increases the RPP and VO₂ Max levels in their study. The changes were due to changes in vagal tone and maximal oxygen consumption according to them.[14]

These results indicate that RPP, easily measurable variable is a valid predictor of MVO₂ during exercise. The RPP is critical in defining the response of the coronary circulation to myocardial metabolic demands.

Conclusion- The observed changes in our study confirm favourable physiological adaptations and better health status as beneficial effects of regular exercise. Training improved the cardiovascular functional status. The knowledge can be adapted to improve cardiovascular and overall health status.

Table-1 Statistical analysis of VO₂ max (ml/kg/min) between female athletes and control Group.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ±S.D. (ml/kg/min)</th>
<th>t ‘ value</th>
<th>p ‘ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases (n=25)</td>
<td>39.35 ±2.78</td>
<td>16.57</td>
<td>p&lt;0.05</td>
</tr>
<tr>
<td>Controls (n=25)</td>
<td>24.02± 3.69</td>
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</table>

Table-2 Statistical analysis of Rate Pressure Product (mm of Hg.bpm) between female athletes and control Group.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean ±S.D. (mm of Hg.bpm)</th>
<th>t ‘ value</th>
<th>p ‘ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases (n=25)</td>
<td>7921.28±649.14</td>
<td>3.51</td>
<td>p&lt;0.05</td>
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<tr>
<td>Controls (n=25)</td>
<td>8652.50±810.69</td>
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