VO$_{2\text{max}}$ IN PREMENOPAUSAL AND POST MENOPAUSAL WOMEN

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ABSTRACT

**Background:** The association between VO$_{2\text{max}}$ and post menopausal state was not established well.

**Objective:** The aim of the present study was to calculate and compare VO$_{2\text{max}}$ between premenopausal and post menopausal women.

**Materials and Methods:** A cross-sectional study was conducted between 60 premenopausal women in the age group of 40-45 years and 60 post menopausal women in the age group of 45-50 years. All 120 subjects underwent treadmill test under modified Bruce protocol. VO$_{2\text{max}}$ was calculated from MET (1 MET = 3.5 ml of oxygen /kg body weight /minute).

**Result:** Postmenopausal women had a lower VO$_{2\text{max}}$ than premenopausal women, which may be associated with a higher total and visceral fat mass in postmenopausal women.

**Conclusion:** Our data suggested that postmenopausal women had a lower VO$_{2\text{max}}$ than premenopausal women.

**Keywords:** VO$_{2\text{max}}$, treadmill test, post menopausal women

INTRODUCTION:

VO$_{2\text{max}}$ is the level of maximal oxygen consumption beyond which there is no further increase in oxygen consumption even with further increase in the severity of exercise. It is measured during incremental exercise, most typically on a motorized treadmill. VO$_{2\text{max}}$ reflects the aerobic physical fitness of the individual and is an important determinant of their endurance capacity during prolonged, sub-maximal exercise. The oxygen utilisation is expressed as MET (Metabolic Energy Expenditure). MET is directly related to the intensity of physical exercise and the amount of the oxygen consumed. 1 MET = 3.5 ml of oxygen /kg body weight /minute, which is the resting oxygen consumption. VO$_{2\text{max}}$ is widely accepted as the single best measure of cardiovascular fitness and maximal aerobic power.

Absolute values of VO$_{2\text{max}}$ are typically 40-60% higher in men than in women. This difference is due to the variance in bodyweight and lean body mass between men and women. The average young untrained female will score a VO$_{2\text{max}}$ of approximately 2 litres/minute.

According to 'The Physical Fitness Specialist Certification Manual, The Cooper Institute for
Aerobic Research, Fitness Assessment & Exercise Prescription' normal value of $VO_{2\text{max}}$) in females (ml/kg/min) are as shown in Table1.3

### Table 1. Normal value of $VO_{2\text{max}}$ in females (ml/kg/min)

<table>
<thead>
<tr>
<th>Age (in years)</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-49</td>
<td>21.3±4</td>
<td>24.5±6.9</td>
<td>29.3±8</td>
<td>32.9±10.9</td>
</tr>
<tr>
<td>50-59</td>
<td>20.7±2.7</td>
<td>22.3±7.9</td>
<td>27.1±4.1</td>
<td>31.8±15.7</td>
</tr>
</tbody>
</table>

### AIM & OBJECTIVES:

The aim of the present study was to calculate $VO_{2\text{max}}$ and to compare the parameter between premenopausal and postmenopausal women.

### MATERIALS AND METHODS

The present cross-sectional study was conducted in 120 healthy non-athletic female volunteers to assess the $VO_{2\text{max}}$.

### Group I:

Sixty premenopausal women between the age group of 40-45 years having regular menstrual cycle.

### Group II:

Sixty post-menopausal women between the age group of 45-50 years who had menopause naturally at least 2 years before.

### Exclusion criteria

1. Diabetes Mellitus
2. Hypertension
3. Obesity
4. Cardiovascular diseases
5. H/O smoking
6. Respiratory diseases which includes obstructive and restrictive lung diseases

Informed written consent was obtained from all the participants. Ethical clearance was obtained from the institutional ethics committee.

The American College of Cardiology/American Heart Association guidelines specify indications for termination of exercise testing were strictly observed. These indications are:

- Drop in systolic blood pressure (SBP) of more than 10 mm Hg from baseline
- Moderate-to-severe angina
- Subject's desire to stop
- Shortness of breath
- Sustained ventricular tachycardia
- ST elevation (> 1 mm) in leads
- Excessive ST depression (> 2 mm)

### Procedure

In all 120 individuals fasting venous blood samples of 3ml was collected in the morning between 7 a.m. and 8 a.m. with aseptic precautions. Results were collected after 2 hours and diabetes mellitus was ruled out. Subjects were advised to take morning breakfast. Before starting the treadmill test, height, weight, pulse rate and blood pressure were recorded. BMI was calculated by using formula, $BMI = \frac{\text{Weight in Kilograms}}{\text{Height in Meter}}$.

2. ECG was taken in supine position and another ECG was taken in standing position for all the subjects. Screening echocardiogram was done by a cardiologist for all the subjects with GE-Vivid ‘e’ portable echocardiogram and structural cardiac abnormalities were ruled out.

Treadmill used for the present study was a BPL-Stress machine, Dynatrac. All the 120 subjects underwent a modified Bruce exercise protocol testing on a treadmill under the supervision of a cardiologist. Heart rate and bloodpressure were recorded at each stage of the exercise and during the recovery period.

The modified Bruce exercise protocol is a description for the increments in speed and gradient in the treadmill test which starts at a lower work load than the standard test (Table 2) and is typically used for elderly or sedentary patients.
Table 2. The modified Bruce exercise protocol consists of seven stages.

<table>
<thead>
<tr>
<th>Stages</th>
<th>Speed (MPH)</th>
<th>Gradient (%)</th>
<th>Duration (min)</th>
<th>Cumulative time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>1.7</td>
<td>0%</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Stage 2</td>
<td>1.7</td>
<td>5%</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Stage 3</td>
<td>1.7</td>
<td>10%</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Stage 4</td>
<td>2.5</td>
<td>12%</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Stage 5</td>
<td>3.4</td>
<td>14%</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Stage 6</td>
<td>4.2</td>
<td>16%</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Stage 7</td>
<td>5.0</td>
<td>18%</td>
<td>3</td>
<td>21</td>
</tr>
</tbody>
</table>

Calculation of VO\(_{2\max}\)

VO\(_{2\max}\) was calculated from METS achieved during peak exercise, which was displayed in software system connected to the treadmill.

1MET = 3.5ml O2/kg Body weight/minute, which is the resting oxygen consumption. Total numbers of METS achieved were multiplied with 3.5 ml of O2 and finally VO\(_{2\max}\) was expressed in ml of O2/kg Body weight/minute.

STATISTICAL ANALYSIS

The present cross sectional study was undertaken to compare VO\(_{2\max}\) between and pre menopausal and post menopausal women. Statistical analysis was done by applying unpaired 't' test.

RESULT

VO\(_{2\max}\) was lower in postmenopausal women group when compared to premenopausal women group.

Figure-1 shows the mean VO\(_2\max\) in premenopausal women was 31.59 ml of O2/kg/minute. The mean VO\(_2\max\) in postmenopausal women was 25.13ml of O2/kg/minute. The difference between the two groups was found to be statistically significant (P value <.0001).

DISCUSSION

Postmenopausal women had a lower VO2max than premenopausal women, which may be associated with a higher total and visceral fat mass in the postmenopausal women. Lynch NA et al. conducted a study to determine whether the lower VO\(_2\max\) in postmenopausal women was associated with a higher total and visceral fat mass. Results showed that VO\(_2\max\) was 17% lower in postmenopausal women compared with premenopausal women. Percentage of body fat was 11% higher, and visceral fat area was 42% higher in postmenopausal women when compared to premenopausal women.\(^6\)

Weight and abdominal fat distribution differ among women of reproductive age and menopausal women. The decrease in oestrogen level in postmenopausal women is associated with the loss of subcutaneous fat and an increase in abdominal fat. Hypoestrogenism has a negative effect on fat metabolism, favoring the appearance of central-body obesity.\(^7\) Rebuffé-Scrive et al.\(^8\) observed that femoral adipocytes from premenopausal women have higher lipoprotein lipase activity and lower lipolytic responsiveness compared to abdominal adipocytes, while this difference was not seen in postmenopausal women. The loss of the relatively higher lipolytic rate in abdominal adipocytes after
menopause may predispose to gain fat in this depot. Orsi et al. conducted a study to assess functional capacity in women with different body mass indices. Results showed that obese women had significantly lower VO\textsubscript{2max} values than groups with overweight and normal BMI, suggesting therefore that the physical fitness of obese women is lower than overweight and normal weight women.\textsuperscript{9}

Likewise, Oliveira et al. analyzed the differences in BMI and waist circumference according to cardiorespiratory fitness through VO\textsubscript{2max} in soldiers and concluded that for the same BMI, individuals with better cardiorespiratory fitness have significantly lower waist circumference when compared to subjects with lower fitness capacity.\textsuperscript{10} These findings suggest a reduction of abdominal fat leads to reductions in visceral fat and waist circumference independent of changes in BMI.\textsuperscript{11}

**CONCLUSION**

Our study showed that postmenopausal women had a lower VO\textsubscript{2max} than premenopausal women. Lower VO\textsubscript{2max} in postmenopausal women may be associated with a higher total and visceral fat mass. The absence of estrogens is an important factor in the onset of cardiovascular disease during the menopausal period, which is characterized by predominant abdominal fat accumulation and lipid profile variations. It is important to counsel the postmenopausal women for proper diet and exercise. It will be helpful to reduce central obesity and cardio vascular morbidity.

**LIMITATIONS OF STUDY**

Unlike adults, BMI is not an accurate predictor of body fat in the elderly. So calculating obesity by using special skin callipers which measures skin fold thickness, measuring waist circumference and hip waist ratio will be more useful to estimate the percentage of body fat accurately. This will determine the association of lower VO\textsubscript{2max} and postmenopausal state in a better way.

**REFERENCES**


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