

Phenomenal effect of body mass index on VO_{2max} in medical students



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ABSTRACT

Background: Decrease in VO_{2max} and/or increase in body mass index can be used as early marker for the alteration of cardiovascular physiology. Still, the debate over fat or fit for the early predictor of cardiovascular disease risk factor exists. **Aims and Objective:** The present study was carried out to evaluate the effect of body mass index on VO_{2max} . **Materials and Methods:** Sixteen female students, group I, normal weight ($n=16$) and group II, overweight ($n=16$) were enrolled as participants. The Queen's College step test was performed on a stool of 16.25 inches (or 41.3 cm) height for a total duration of 3 min at the rate of 22 cycles/min set by a metronome. **Results:** The average age, BMI, VO_{2max} and sleep duration for normal weight and overweight female participants were 19.25 ± 0.73 years vs 19.43 ± 0.92 years, 20.87 ± 1.17 kg/m² vs 26.1 ± 0.31 kg/m²; 36.98 ± 0.76 ml/kg/min vs 36.55 ± 0.78 ml/kg/min; 7.81 ± 0.53 hours/day vs 6.23 ± 0.16 hours/day respectively. **Conclusion:** The relative lower value of aerobic capacity (VO_{2max}) in overweight female as compared to normal weight females may not be an indicator of cardio-respiratory dysfunction, and it is imperative not to make the early extrapolation that all overweight individuals suffer from cardio-respiratory dysfunction and are physically unfit.

Key words: Body mass index, Cardio-respiratory fitness, Overweight, VO_{2max}

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INTRODUCTION

Fitness is the ability of the organism to maintain the homeostasis as closely as possible to the resting state during strenuous exercise and to restore it promptly after exercise.¹

A convenient and reliable indicator of body fat is the body mass index (BMI), which is body weight (in kilograms), divided by the square of height (in meters). BMI >25 are stated as abnormal. Individuals with values of 25-30 are considered overweight, and those with values > 30 are obese. Decreased physical activity is undoubtedly a factor in increasing BMI.²

Maximal oxygen uptake (VO_{2max}), the maximum cardiac output and maximal arterio-venous oxygen difference,³ is widely accepted as the single best measure of cardiovascular fitness and maximal aerobic power.⁴ VO_{2max} averages about 29 ml/kg/min in active healthy women.⁵

Medical students are compelled to spend most of their time in studying their huge course and spare little time to do exercise, or play outdoor games etc, and thereby have more chance to attain higher BMI. Several prospective studies showed that overweight as one of the risk factor for cardiovascular accident.^{6,7} Moreover, Jones et al study reported that the increase in the BMI have negative impact on respiratory function.⁸

Hence, this study was designed to evaluate the effect of BMI on cardio respiratory fitness (CRF) in terms of VO_{2max} , the single best measure of cardiovascular fitness and maximal aerobic power, in female medical students.

MATERIALS AND METHODS

The study was carried out after taking written consent from the participants. Young apparently healthy, sedentary non-smoker female medical students (1st and 2nd year MBBS

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and BDS) of age group 18 to 22 years were selected for the study. During orientation program, the experiment protocol and objectives of the study were fully explained to them.

The experiment, after sanctioned by ethical committee, was done at 9-11 AM in the month of February/March 2017 in the department of physiology. The room temperature was maintained at 22-26°C. The participants had no history of any major disease and did not follow any physical training program. Their height and weight were measured with the help of height measuring stand and weighing machine. After calculating Body Mass Index (BMI), it was found that there were only sixteen overweight females; thus, volunteers were divided into two groups. Group 1 (number=16) comprised normal weight participants ($18.5 \leq \text{BMI} < 25$) and Group 2 (number=16) comprised overweight participants ($25 \leq \text{BMI} < 30$).⁹

Then, The Queen's College step test, the simplest one to determine cardio-respiratory fitness in terms of maximum oxygen uptake, was performed on a stool of 16.25 inches (or 41.3 cm) height for a total duration of 3 min at the rate of 22 cycles/min which was set by a metronome. After completion of the exercise, the participant was asked to remain standing and the carotid pulse rate was measured from 5 to 20 seconds of the recovery period. This 15 second pulse rate was converted into beats/min and the following equation was used to predict the maximum oxygen uptake capacity (VO_{2max}).¹⁰

VO_{2max} (ml/kg/min) = $65.81 - (0.1847 \times \text{pulse rate in beats per min})$

In addition, their sleeping duration was also noted.

Statistical analysis was performed using student's unpaired t-test in excel. $p \leq 0.05$ was considered significant.

RESULTS

Comparative study of anthropometric parameter, VO_{2max} and sleep duration between normal weight and overweight participants are presented in

Table 1. The average age, BMI, VO_{2max} and sleep duration for normal weight and overweight female participants were 19.25 ± 0.73 years vs 19.43 ± 0.92 years, $20.87 \pm 1.17 \text{ kg/m}^2$ vs $26.1 \pm 0.31 \text{ kg/m}^2$; $36.98 \pm 0.76 \text{ ml/kg/min}$ vs $36.55 \pm 0.78 \text{ ml/kg/min}$; 7.81 ± 0.53 hours/day vs 6.23 ± 0.16 hours/day respectively.

DISCUSSION

Medical students are compelled to spend most of their time in studying their huge course; spare little time to do exercise, play outdoor games etc, and even get lesser time to sleep than the required for the restoration of homeostatic mechanism—and thereby have chance to attain higher BMI. Epidemiological studies have reported a negative association between BMI and sleep duration in adults and adolescents.¹¹⁻¹³ Similar results were found in the present study- overweight female participants were found to spend less sleep duration than normal weight female participants, ($p < 0.001$).

Several previous studies have reported negative correlation between BMI and CRF, in term to VO_{2max} (ml/kg/min).¹⁴⁻¹⁸ However, present study showed that despite having significant difference between BMI in Group 1 and Group 2, ($p < 0.001$); the VO_{2max} in Group 1 and Group 2 was statistically insignificant, ($p = 0.178$). VO_{2max} value of our participants is above the average value in active healthy women,⁵ and according to Katch et al¹⁹ our participants VO_{2max} lies in good category.

Barry et al in their meta-analysis combined CRF and BMI categories and reported the phenomenal relationship between CRF and BMI i.e. Fit individuals who are overweight or obese are not automatically at a higher risk for cardio respiratory disease.²⁰ Furthermore, the fitness-fatness hypothesis, suggested a higher level of CRF substantially reduced the adverse effects of BMI, making overweight and obesity a much less important factor for health.^{21, 22}

These findings are promising for all individuals, including those unable to lose weight or maintain weight loss, as all can experience significant health benefits by developing

Table 1: Comparison of some anthropometric parameters, VO_{2max} and sleep duration (n=16)

Variables	Mean \pm SD		p value	Remarks
	Normal weight female	Over weight female		
Age (years)	19.25 \pm 0.73	19.43 \pm 0.92	0.565	NS
BMI (kg/m ²)	20.87 \pm 1.17	26.1 \pm 0.31	<0.001	HS
VO_{2max} (ml/kg/min)	36.98 \pm 0.76	36.55 \pm 0.78	0.178	NS
Duration of sleep (hours/day)	7.81 \pm 0.53	6.23 \pm 0.16	<0.001	HS

SD: Standard deviation; NS: Non significant; HS: Highly significant

and maintaining a moderate level of CRF by participating regularly in physical activity (e.g. brisk walking, biking) currently recommended by the U.S. Physical Activity Guidelines.^{20, 23}

In a nut shell, the relative lower value of aerobic capacity (VO_{2max}) in overweight female as compared to normal weight females may not be an indicator of cardio-respiratory dysfunction, and it is imperative not to make the early assumption that all overweight individuals suffer from cardio-respiratory dysfunction and are physically unfit.

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Author's contribution:

RP- Concept and design of the study, literature search, data collection and its interpretation, manuscript preparation and critical revision of the manuscript.

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