Original Article

Assessment of aerobic capacity in overweight young females: A cross-sectional study

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Abstract

Context: Overweight/obese people are prone to develop cardiovascular, respiratory and other chronic diseases at young age because of abnormal weight. Aerobic capacity (VO_2 max) is an accepted index of cardio respiratory fitness. Decrease in VO_2 max can be an early marker for altered cardiovascular physiology. **Objectives:** The present study was carried out with the objective of evaluating aerobic capacity in overweight young females and comparing it with that of normal weight females. **Materials and Methods:** Twenty-three female subjects aged 18–20 years were enrolled in each group. Group 1 comprised overweight subjects and group 2 comprised normal weight subjects. Analysis to assess the difference in VO_2 max between the groups was done by unpaired *t*-test. **Results:** Mean age of group 1 and 2 was 18.91 ± 0.67 years and 18.83 ± 0.78 years, respectively. Mean BMI in group 1 and 2 was 26.18 ± 1.06 kg/m^2 and 20.65 ± 1.5 kg/m^2 respectively. VO_2 max in groups 1 and 2 was 34.52 ± 3.26 ml/min/kg and 37.51 ± 2.88 ml/min/kg respectively. The difference in VO_2 max found in overweight girls was statistically significant with *P* value of 0.002. **Conclusion:** Overweight girls had significantly reduced, cardio-respiratory fitness when compared to normal weight young females.

Key words: Body mass index, cardio-respiratory fitness, obesity, VO_2 max

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Introduction

Obesity is associated with chronic lifestyle related disorders particularly cardiovascular and respiratory diseases.[1,2] The course of early life overweight/obesity toward development of cardiovascular disease involves gradual decrease in cardio-respiratory efficiency. Physical fitness, which may be used as an indicator of cardiopulmonary efficiency has been found to be more effective than assessment of physical activity in the prediction of health outcome in an individual. Physical fitness in children has been found to be associated with better health outcomes in terms of blood pressure, muscle strength, blood lipids, serum insulin or blood vasculature characteristics.[3-5] Cardio-respiratory efficiency can be assessed by evaluating maximal oxygen consumption (VO_2 max) also called as aerobic capacity and indicates the physical fitness of a person.[6-9] Evaluating VO_2 max in overweight people can help in early detection of physiological alterations which can help in designing appropriate intervention strategies. Thus, there is a need to assess the change in cardio-respiratory efficiency at an early stage in life. The present study was carried out to evaluate aerobic capacity in overweight young females and comparing it with that of normal weight females.

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Materials and Methods

The present cross-sectional study was carried out after taking due permission from the Institutional Ethics Committee. Sample size was calculated for detecting a large effect size (Cohen's *d* = 0.9) with α as 0.05 and power of study as 80% for two tailed hypothesis testing.

Twenty-three apparently healthy female subjects aged 18–20 years who gave informed consent for the study

were enrolled in each group. Group 1 comprised overweight subjects (25 ≤ body mass index [BMI] <30) and group 2 comprised normal weight subjects (18.5 ≤ BMI < 25) as per BMI reference range of World Health Organization.[10] Subjects with history of cardiopulmonary disease, hepatic or renal impairment, medication, chronic illness, any major surgery, undergoing any physical conditioning program or involved in sports activity were not included in the study groups. Weight was recorded to the nearest 1 kg with clothing on a standard scale and height was measured to nearest one cm without footwear. BMI was calculated by Quetlet's index (kg/m^2). All the recordings were done in the clinical laboratory of the Department of Physiology. To account for diurnal variation, all the readings were taken in the morning after light breakfast. The study duration was 2 months.

Estimation of VO_2 max by queens college step test

It was performed using stepping bench with 16.25 inches height. Stepping was done for total duration of 3 min at the rate of 22 steps ups/min. After completion of exercise carotid pulse rate was measured from 5th to 20th second of recovery period. It was converted into pulse rate per minute. Following equation as described along with the procedure in McArdle, Katch and Katch's Exercise Physiology[11] was used to estimate VO_2 max expressed in milliliters per kilogram body weight per minute.

VO_2 max (ml/kg/min) = 65.81 – (0.1847 × pulse rate in beats/min).[11]

Statistical analysis was performed using Student's unpaired *t*-test using online GraphPad (GraphPad Software Inc. California, USA) software.

Results

All the subjects were able to complete the Queens College Step Test protocol for full 3 min without break. Table 1 shows the characteristics of each group. Mean age and BMI in overweight group was 18.91 ± 0.67 years and 26.18 ± 1.06 kg/m^2 respectively. Mean age and BMI in normal weight group was 18.83 ± 0.78 years and 20.65 ± 1.5 kg/m^2 respectively. The VO_2 max in overweight females was 34.52 ± 3.26 ml/kg/min whereas it was 37.51 ± 2.88 ml/kg/min in normal weight females. Thus, the overweight females had significantly lower aerobic capacity (VO_2 max) when compared with normal weight females with a P = 0.002 as shown in Table 2.

Table 1: Anthropometric parameters of overweight and normal weight females

Parameter	Mean±SD	
	Overweight	Normal weight
Age (years)	18.91±0.67	18.83±0.78
Height (cm)	154.74±5.34	155.50±4.84
Weight (kg)	62.78±5.35	50±4.92
BMI (kg/m^2)	26.18±1.06	20.65±1.5

SD: Standard deviation; BMI: Body mass index

Table 2: Aerobic capacity of overweight and normal weight females

Parameter	Overweight (mean±SD)	Normal weight (mean±SD)	Difference in means (95% CI)	*P* value	Effect size
Recovery HR (beats/min)	169.4±17.6	153.2±15.3	16.2 (6.3 to 26.1)	0.002*	0.98
VO_2 max (ml/kg/min)	34.52±3.26	37.51±2.88	−2.99 (−4.82 to −1.17)	0.002*	0.97

*Indicates statistically significant. SD: Standard deviation; CI: Confidence interval; HR: Heart rate

Discussion

In the present study, VO_2 max relative to body weight was found to be significantly less in overweight young females when compared to normal weight females. This indicates that the ability to carry out exhausting work is considerably less in overweight young females. Reduction in cardiopulmonary fitness even in young overweight females who are below the cut off values of BMI of 30 kg/m^2 to be labeled as obese is a significant alert. However, it can be explained by the influence of excess fatty tissue on the physiology of cardiac and respiratory systems, which has been explored by various research works done in overweight and obese individuals.

Obesity has been found to be associated with a spectrum of various cardiovascular abnormalities, which range from a state of hyperdynamic circulation to evidence of subclinical changes in cardiac structure.[12-14] Wong *et al*. have reported that even if we adjust for age, gender, mean arterial pressure and left ventricular mass, being overweight is independently associated with subclinical changes in left ventricular structure in subjects without an overt heart disease.[15] Cardiac function has been found to correlate with BMI as well as the duration of obesity.[16] This signifies the importance of early detection and intervention at an early stage to prevent the cardiac disease in overweight/obese individuals. Obesity adversely affects the respiratory system causing a deviation in respiratory mechanics, decreasing the endurance and strength of respiratory muscles, decreased gas exchange and limitations in the lung function and the exercise capacity. Lung function impairment is supposed to be caused by the extra amount of adipose tissue in chest wall and the abdominal cavity, which may compress the thoracic cage, diaphragm, and lungs. This may limit diaphragm displacement and compliance of the lung and chest wall. This results in a decrease in lung volumes.[17-21]

The impact on respiratory function worsens with an increase in the BMI of individual.[22]

Study by Davies *et al*.[23] has reported that on maximal exercise, obese females showed a marked decrease in the exercise performance when compared with control group. Furthermore, it was observed that absolute VO_2 max was similar in obese and control subjects but VO_2 max per kilogram body weight was reduced significantly in the obese group. Goran *et al*.[24] also found VO_2 max expressed relative to body weight was reduced significantly in obese individuals and that VO_2 max expressed relative to body weight improved significantly by around 15% after weight reduction in the obese group.

Limitations of this study include the cross-sectional design which cannot comment upon the cause-effect relationship between overweight status and aerobic capacity status. Larger and longitudinal studies need to be done to further the understanding on the subject. Interventional studies can help in evaluating whether there can be improvement of cardiopulmonary efficiency in obesity with weight loss.

To summarize the lower aerobic capacity in overweight females may be an early indicator of cardio-respiratory dysfunction. We can hypothesize that obesity may lead to reduced ability to maximally consume oxygen and therefore has detrimental effect on VO_2 max. Thus, it is necessary to take steps for primary prevention for the control of the overweight/obesity syndrome.

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