Research Article

A study on cardiovascular fitness of male medical students

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ABSTRACT

Background: Cardiovascular fitness has been found to be significantly compromised by obesity, whose prevalence is increasing rapidly. The present study aimed to assess the aerobic exercise performance in terms of maximum aerobic power (VO_2 max) of the male students of North Bengal medical college in the age range of 18-22 years.
Methods: The subjects were divided into two groups viz. control (N=52) and study (N=43) on the basis of Body Mass Index (BMI) and Waist Circumference (WC), according to the current Indian guidelines for obesity. The VO_2 max was compared among the two groups. It was evaluated using the Bruce protocol, and also expressed in terms of 'Metabolic equivalents' (MET).
Results: VO_2 max exhibited significant negative correlation with BMI (r=0.75, P <0.000) and WC (r=0.72, P <0.000). VO_2 max was higher for the normal group compared to the study group, and the mean difference was significantly different [P <0.05(0.000)].
Conclusion: The study thus showed that cardiovascular capacity is compromised by excess adiposity.

Keywords: Obesity, VO_2 max, BMI, Waist circumference, Bruce protocol, Metabolic equivalent

INTRODUCTION

Physical fitness refers to a physiologic state of well-being that allows one to meet the demands of daily living and provides the basis for sport performance. Cardiovascular or aerobic fitness is the cornerstone of physical fitness, which is commonly measured by a person's maximum aerobic power (VO_2 max) and which has been found to be significantly compromised by obesity. VO_2 max is the maximum amount of oxygen utilization by the muscles during maximal aerobic metabolism.[1] The study of obesity in relation to cardiovascular and metabolic diseases and physical fitness is of major concern as the prevalence of obesity is increasing rapidly worldwide. For cardiovascular patients, aerobic exercises have been found to be effective in improving the functioning of the heart and partially reverse the risk for cardiac diseases.[2,3]

The World Health Organization has standardized the cut-off values for the anthropomorphic indices like BMI and WC for categorizing subjects into lean, overweight and obese.[4] But because of variations in body proportions, the standard BMI and WC classification may not reflect the actual body fat percentage in different populations. Owing to this fact, the obesity guidelines for the Indian population had been revised recently, and were released jointly by the Health Ministry, the All-India Institute of Medical Science (AIIMS), Indian Council of Medical Research and the National Institute of Nutrition.[5]

There is a general paucity of studies on exercise testing and performance among the various age groups of the Indian population with regard to obesity and cardiovascular fitness. Also such study is sorely lacking among the college students, who belong to the 'young

adult' age group. The young generation has been accustomed to a sedentary lifestyle and has decreasing fitness levels, increasing obesity and thus is exposed to their adverse consequences. The student communities, who face a lot of academic and peer pressure are one of the most vulnerable subsets of this population. The present study, conducted on medical students, aimed to contribute to an understanding of the fitness and obesity scenario among these young adults. Furthermore this study had incorporated the revised obesity guidelines framed by the Govt. of India and would thus assess the effectiveness and impact of the new guidelines as obesity and fitness indicator.

METHODS

The present study was undertaken in the dept. of physiology, North Bengal Medical College (NBMC). The study was conducted on the male medical students, and it was approved by the ethics committee of NBMC. The participants in the study belonged to an age group of 18-22 years and had a mixed geographical and socio-economic background. The participating subjects completed a questionnaire designed to screen for disease, smoking and addiction, family and medication history. The default physical activity patterns of the subjects were assessed using 'The Healthy Physical Activity Participation Questionnaire' of the Canadian Society of Exercise Physiology (CSEP).[6] Subjects were also screened to confirm the presence or absence of any existing medical condition and contra-indication or on-going drug treatment that might affect their exercise performance. The subjects who fulfilled the selection criteria, gave informed consent and had similar physical activity profile were included in the study (n=95).

Anthropometric measurements were performed on the subjects, which included height, weight and Waist Circumference (WC). The weight of each participant was measured using electronic scale to the nearest 0.1 kg (ATCO AHP-12 Personal Weighing Scale, Atcom Technologies Ltd. India). The standing height was measured to the nearest cm (Stadiometer (supplied by Avery India Ltd). The Body Mass Index (BMI) was then calculated as the weight in kilograms divided by the square of the height in meters. The waist circumference was measured twice and a third time if the difference between the first two measurements was greater than 5% (± 1 cm), and the two closest measurements were averaged to the nearest 0.1 cm.

The subjects were then divided into a 'study' group and a 'control' group based on these anthropometric indices according to the current Indian guidelines for Obesity. The 'overweight/obese' subjects, with BMI ≥23 and/or WC >90 cm, formed the 'study' group (n=52); while subjects with normal BMI (18.5-22.9) and WC formed the 'control' group (n=43) respectively.

Cardiovascular fitness was assessed by using 'Whispermill 594XL' computerised treadmill, running on 'SPANDAN' software, version 4.0 (both supplied by Schiller Health Care India Pvt. Ltd). The treadmill was programmed to increase in gradient and speed every 3 min, in seven stages, according to the Bruce protocol.[7] The Borg scale for 'Rating of Perceived Exertion' (RPE) was shown and explained to the subject, to enable him to provide his feedback after the test. The heart rate and ECG were monitored continuously before, during and after the test. Blood pressure of each subject was measured just prior to the test, after the completion of each stage and immediately after the test. During the test, the subject was continuously monitored for the appearance of any warning signs/symptoms or ECG changes indicating cardiovascular compromise, to ensure safety and avoid adverse outcome. The treadmill test was continued till the subject achieved the Target Heart Rate (THR) or premature termination due to appearance of any warning sign or fatigue of the subject. Achieving the THR has been taken as the end-point for successful completion of the exercise test and indicates a satisfactory level of cardiovascular fitness. It is obtained from the following formula: THR = 85% × (maximum heart rate). Maximum heart rate (MHR) is the age-predicted maxima achievable, and is obtained for adult males by the following formula: MHR = 220 − Age (in years).[8]

Immediately after the completion of the test, the subject provided his feedback regarding the intensity or difficulty of the exercise session from the Borg scale for RPE.[9] The total exercise duration in minutes was noted. The post-exercise recovery period continued till the heart rate and blood pressure returned to baseline. The aerobic exercise capacity of the subject was then judged from VO_2 max and is also expressed in terms of METs.[1,10] VO_2 max was calculated from the total exercise duration, and expressed in the unit of 'ml/kg/min', according to the following formula:

$$VO_2 \text{ max} = 14.8 - (1.379 \times T) + (0.451 \times T^2) - (0.012 \times T^3). \text{ (T – Total exercise time in min)}.$$

The MET value was then derived from the VO_2 max according to the following relations:

1 MET = 3.5 ml O_2/kg/min. Therefore, Total MET = VO_2 max/3.5.

The frequency distribution of the data for the different set of study variables was determined for the entire study population. Bi-variate analysis was used to determine the co-relation co-efficient between the different data sets. Pearson correlation was done, where r <0.5 was regarded as weak while r >0.5 was regarded as strong correlation, while the '+' and '−' signs indicated the direction of correlation. Subsequently, Independent T-test was used to compare the data according to the study variables between the 'study' and 'control' groups. The data were

entered into the Microsoft office excel spreadsheet and subsequently analysed using the statistical analysis software SPSS (v.16).

RESULTS

The study was conducted with 95 participants in the age group of 18-22 years, of whom 43 (45.26%) were overweight/obese and 52 (54.74%) were normal according to current guidelines. The set of study parameters that were recorded with each subject are VO_2 max, METs and RPE. The two anthropometric indices used were BMI and WC.

Correlation between the study variables and each of the anthropometric indices is shown in Table 1. RPE is correlated with both BMI and WC, while VO_2 max and MET show strong negative correlation with both BMI and WC.

Table 1: Correlation between the study variables and each of the anthropometric indices.

Parameter	VO_2 max	MET	RPE
BMI	-0.751**	-0.751**	0.469**
Correlation(r) Sig. (2-tailed)	0.000	0.000	0.000
WC	-0.718**	-0.718**	0.547**
Correlation(r) Sig. (2-tailed)	0.000	0.000	0.000

**Correlation (Pearson) is significant at the 0.01 level (2-tailed)

Comparison of the study variables among the Study group (N=43) and Normal group (N=52) is made according to BMI and is shown in Table 2. Means of the different study parameters are different among the two groups. RPE is more in Study group, while VO_2 max and MET are more in the normal group. The mean differences are significantly different in case of all the parameters (P <0.05).

Table 2: Comparison of the study variables among the subgroups of the study population made according to BMI.

Parameters	Study (Mean ± SD) [N=43]	Normal (Mean ± SD) [N=52]	Significance (P value)
VO_2 max	21.08 ± 2.81	29.79 ± 3.46	<0.05 (0.000)
MET	6.02 ± 0.8	8.51 ± 0.99	<0.05 (0.000)
RPE	12.74 ± 1.29	11.71 ± 0.78	<0.05 (0.000)

Similarly, comparison of the study variables among the Study group (N=13) and Normal group (N=82) is made according to WC and is shown in Table 3. Means of the different study parameters are different among the two groups. RPE is more in the Study group (above cut-off), while VO_2 max and MET are more in the Normal group

(below cut-off). Mean differences are again significantly different in case of all the parameters (P <0.05).

Table 3: Comparison of the study variables among the subgroups of the study population made according to WC.

Parameters	Study (Mean ± SD) [N=13]	Normal (Mean ± SD) [N=82]	Significance (P value)
VO_2 max	19.37 ± 3.52	26.87 ± 4.9	<0.05 (0.000)
MET	5.53 ± 0.28	7.68 ± 1.4	<0.05 (0.000)
RPE	13.77 ± 1.36	11.93 ± 0.9	<0.05 (0.000)

DISCUSSION

It is well known that sedentary lifestyle, obesity, decreased physical fitness and cardiovascular risk factors are interrelated.[4] The effects of these risk factors are reflected through poor cardiovascular conditioning and can be evidenced from a decline in aerobic exercise capacity. And exercise duration, reflecting functional capacity, is one of the strongest and most consistent prognostic markers identified in exercise testing.[11,12]

The present study has attempted to validate the hypothesis that excess adiposity in an individual acts as a metabolic burden and leads to a decline in cardiovascular capacity as compared to normal lean subjects. The Health ministry had in the recent past formulated new guidelines for diagnostic cut-offs to classify Indians as overweight or obese, and released it as the 'Consensus Guidelines of Obesity, Diabetes and Metabolic Diseases'.[5] These guidelines fix the BMI cut-off for overweight at 23 kg/m^2 and the WC cut-off for overweight males at 90 cm. We have incorporated these guidelines in our study to assess their impact as predictors of adiposity.

This study points to a decline of aerobic exercise capacity with increasing adiposity. The mean exercise duration was 6.23 ± 1 minutes among the 'study' group and 8.87 ± 0.93 minutes among the 'control' group. Consequently the VO_2 max was 21.08 ± 2.81 ml/kg/min in the 'study' group and 29.79 ± 3.46 ml/kg/min in the 'control' group. Karl Pearson's regression analysis reflected the statistically significant negative correlation between VO_2 max and MET with both BMI (r = 0.75, P <0.000) and WC (r = 0.72, P <0.000). This finding is also validated by other studies where the total exercise durations were significantly shorter in the obese group compared to the non-obese, in spite of the fact that different authors used different exercise protocols in their respective studies.[13-21]

Our study also assessed the subjective response to the intensity of the exercise effort through the Borg scale for RPE. It showed that the 'study' group reported greater exertional scores compared to the normal subjects. The mean RPE scores in the obese and normal subgroup respectively are 12.74 ± 1.29 vs. 11.71 ± 0.78 [P <0.05 (0.000)]. Borg ratings from other studies have also

reported significantly higher perceived exertion among the obese subjects than controls.[14,16,17] This can be due to the fact that obese subjects incur a greater aerobic cost because of their decreased aerobic efficiency which in turn leads to an increased awareness of fatigue that poses a limitation to the exercise effort.

The study population was divided into normal and 'study' groups based on both BMI and WC, giving rise to a pair of subgroup sets. Comparisons of VO_2 max and MET were done with respect to both BMI-based subgroups and the WC-based subgroups. Results presented identical trends among both pair of sets. Thus in this study both BMI and WC have performed satisfactorily as independent indicators of adiposity & body composition.

However an interesting observation surfaced regarding the above mentioned process of sub-grouping of the total study population (N=95). When BMI was taken to be the delineating factor, the 'normal' group comprised of 52 subjects and the 'study' group comprised of 43 subjects (Table 2). But when WC criteria were applied to the study population, the 'normal' group comprised of 82 subjects, while the 'study' group comprised of only 13 subjects (Table 3). This discrepancy automatically leads to the conclusion that there is a further subgroup hidden in the study population who are 'overweight' by BMI standards but 'normal' by WC standards. Surprisingly we failed to identify any subset conforming to the opposite scenario i.e. overweight by WC but normal by BMI criteria. Though we had set the selection criteria to be 'BMI and/or WC' to segregate the overweight subjects, because of the above mentioned distribution of the anthropometric indices, BMI thus acted as the dominant parameter by default. However, we've not created any additional subgroups based on the above observations. Owing to the limited scale of the study, subjects were not segregated according to a more detailed classification of obesity included in the guidelines. Also further research on a broader population base is required to provide follow-up on the accuracy and impact of the current anthropometric guidelines and how the different indices synchronize with each other.

CONCLUSION

We thus conclude that excess adiposity imposes a metabolic burden on individuals leading to compromised cardiovascular efficiency and endurance. The reduced oxygen utilization by the adipose tissue, and its limitation on oxygen uptake by the working muscles have led to reduced VO_2 max among the overweight. The increasing metabolic cost extracted by the fat mass on the overall exercise effort is also evident from the higher RPE scores reported by overweight subjects after exercise.

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