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Original Research Article

Cardio-respiratory Fitness in Medical Students by Queen's College Step Test: A Cross-sectional Study

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ABSTRACT:

Introduction: Cardio-respiratory fitness indicates the ability of circulatory system to supply oxygen to working muscles during continuous physical activity. Maximum oxygen uptake (VO_{2max}) is a single best measure of cardio-respiratory fitness and is considered gold standard to quantify aerobic capacity. **Methods:** Eighty students of age group 18-25 years were taken by simple random sampling. VO_{2max} was estimated indirectly by following the protocol of Queen's College Step Test (QCST) method. **Results:** Mean value of VO_{2max} for male (51.61±6.26 ml/Kg/min) and female (36.02±3.71 ml/Kg/min) was compared, which was found significantly higher in males than in females ($p<0.001$). There was negative correlation of gender ($r = -0.838$), body mass index (BMI) ($r = -0.339$), obesity category ($r = -0.275$), obese vs non-obese ($r = -0.264$) and basal pulse rate ($r = -0.456$) with VO_{2max} and positive correlation of height ($r = 0.592$) and hours of study($r = 0.309$) with VO_{2max}. **Conclusion:** This study showed that increased BMI is associated with decreased level of VO_{2max} in young adults. One can improve VO_{2max} by maintaining BMI within normal limits.

Keywords: Aerobic capacity, Circulatory system, Fitness, Oxygen, Physical activity

INTRODUCTION:

Cardio-respiratory fitness indicates the ability of circulatory system to supply oxygen to working muscles during continuous physical activity.[1] Inadequate physical activity is responsible for about one third of deaths due to coronary heart disease, diabetes and colon cancer. Rising level of obesity is also contributing to these diseases.[2]

Maximal oxygen consumption (VO_{2max}) is the maximum amount of oxygen an individual can breathe in and utilize it to produce energy ie, ATP aerobically.[3] The direct measurement of VO_{2max} requires an extensive laboratory, specialized equipments and considerable physical effort and motivation. These considerations increase the importance of sub maximal exercise test to predict VO_{2max} from performance during walking or running or from heart rate during or immediately after exercise.[4] To generalize, heart rate to predict VO_{2max} is simple and valid.[5] Exercise tests represent an important clinical tool to evaluate cardio respiratory fitness and to predict future adverse cardiovascular events.[6] The linear relationship of heart rate and

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VO_{2max} has been successfully employed in a number of fitness tests.[7,8,9]

Medical students are future physicians and a good physician must be physically fit and mentally alert.[10] They exercise less frequently and are subjected to different kinds of stress mainly due to heavy academic work load. It is important to measure and analyze their physical fitness for their own benefit and improvement to maintain healthy lifestyle. The present study is aimed to assess and compare the effect of various physical and academic parameters on cardio-respiratory fitness in terms of maximum aerobic capacity (VO_{2max}) in adult males and females.

METHODS:

This was an analytical cross-sectional study conducted in the Department of Physiology, Lumbini Medical College (LMC), Pravas, Tansen, Palpa. The study was carried out from September 2018 to December 2018. It included apparently healthy males and females between age group of 18-25 years willing to participate voluntarily. Participants having any acute or chronic illness, cardiovascular disease, respiratory disease and joint disease were not included in the study.

Ethical clearance was obtained from Institutional Review Committee of the institute (IRC-LMC 12-H/018) prior to data collection. The sample size was calculated using the formula $n=2(Z_{\alpha}+Z_{1-\beta})^2\sigma^2/\Delta^2$. Based on the study by Nabi T et al.[10]

Standard deviation $\sigma = 8.96$,

estimated effect size $\Delta=7.81$

$Z_{\alpha}=1.96$ (at 5% level of significance)

$Z_{1-\beta}= 0.8416$ (at power of 80%).

Simple random sampling was used to collect data and there was attrition of 25%. As sample size of 30 was desirable, final sample size was 40 participants in each group.

Eighty participants, who fulfilled eligibility criteria, were recruited for the study after obtaining their consent. Prior explanation about the aim and purpose of the study, test procedure, method of testing and instructions on how to perform test were given. All participants were tested under similar laboratory conditions in comfortable environment. They were instructed not to indulge in any activities before the test and not to have heavy meals/tea/coffee at least two hours prior. Detailed history was taken and clinical examination was done to rule out cardio-respiratory and musculoskeletal illnesses.

The anthropometric data including age, height, weight was noted and Body Mass Index [BMI] was calculated as body weight in kilograms divided by square of height in meter, using Quetelet index.[11] Normal weight was defined as BMI 18.5 to 22.9 Kg/m^2, underweight as BMI < 18.5 Kg/m^2, over weight as BMI 23 to 24.9 Kg/m^2, obese as BMI 25 to 29.9 Kg/m^2 and morbidly obese as BMI ≥ 30 Kg/m^2.[12]

Participants were asked to rest at least for five minutes before commencement of test and all basal parameters like pulse rate and blood pressure were measured.

VO_{2max} was estimated indirectly by following the protocol of Queen's College Step Test (QCST) method. Individuals stepped to a four-step cadence ("up-up-down-down") using a tool of 16.25 inches height (height of standard gymnasium bleachers).

Stepping was done for a total duration of three minutes at the rate of 24 steps up per minute set by a metronome at a setting of 96 beats per minute for males and 22 steps up per minute set by a metronome at a setting of 88 beats for females. Stepping was started after a brief demonstration and practice period. After completion of stepping, radial pulse was measured for 15 seconds (5-20 seconds into recovery period). The 15 seconds pulse rate was converted into beats per minute (PR x 4) and following equation was used to predict VO_{2max}.[13]

For males: VO_{2max} = 111.33 – [0.42 × pulse rate (beats/min)] [ml/Kg/min]

For females: VO_{2max}= 65.81– [0.1847 × pulse rate (beats/min)] [ml/Kg/min]

The data was collected, compiled and analyzed using Statistical Package for Social Sciences (SPSS™) software 16.0. Analysis was done using descriptive statistics like frequency, percentage, mean and standard deviation, and inferential statistics like student's t-test and Pearson correlation analysis. p value < 0.05 was considered significant.

RESULTS

There were 80 participants in the study of which 40 were males and 40 females. The mean age of the participants was 19.49±1.62 years. There

Table 1. Mean values of study parameters.

Parameters	Mean±SD (Male, n=40)	Mean±SD (Female, n=40)	Mean±SD (n=80)	p value
Age (Years)	19.35±1.85	19.63±1.35	19.49±1.62	0.450
Height (m)	1.69±0.06	1.57±0.06	1.63±0.08	<0.001
Weight (Kg)	61.42±7.85	58.22±12.63	59.82±10.57	0.178
BMI (Kg/m^2)	21.38±2.44	23.44±4.42	22.41±3.69	0.012
Basal Pulse Rate (beats/min)	77.55±8.45	86.00±9.45	81.78±9.87	<0.001
Basal Systolic BP (mm Hg)	118.50±9.20	111.95±9.80	115.23±10.01	0.003
Basal Diastolic BP (mm Hg)	72.55±7.40	70.50±9.41	71.53±8.47	0.282
Basal Pulse Pressure (mm Hg)	45.95±9.16	41.45±7.62	43.70±8.67	0.019
Basal Mean Arterial Pressure (mm Hg)	87.87±6.79	84.32±8.84	86.09±8.03	0.047
Hours of Study per day	3.48±1.47	2.70±1.14	3.09±1.36	0.012
Academic percentage (%)	77.35±4.46	76.36±5.30	76.86±4.89	0.371
Sleeping Hours per day	7.15±1.12	6.60±1.23	6.88±1.20	0.040

was no significant difference in the age (p=0.450), weight (p=0.178), basal diastolic blood pressure (p=0.282) and academic percentage (p=0.371) of male and female students. Statistically significant difference was found in height (p<0.001), BMI (p=0.012), basal pulse rate (p<0.001), basal systolic blood pressure (SBP) (p=0.003), basal pulse pressure (PP) (p=0.019), basal mean arterial pressure (MAP) (p=0.047), hours of study per day (p=0.010) and hours of sleep per day (p=0.040) among male and female participants (Table 1). Majority of males and females were in "normal" category according to BMI (Table 2).

Table 2. Body Mass Index (BMI) of the participants (N=80).

BMI	Female	Male	Total
Underweight (< 18.5 Kg/m^2)	3	4	7
Normal (18.5 to 22.9 Kg/m^2)	18	24	42
Overweight (23 to 24.9 Kg/m^2)	8	8	16
Obese (25 to 29.9 Kg/m^2)	6	4	10
Morbidly obese (≥ 30 Kg/m^2)	5	0	5
Total	40	40	80

Mean values of VO_{2max} for males (51.61±6.26 ml/Kg/min) and females (36.02±3.71 ml/Kg/min) were compared, which was found significantly higher in males than in females (p <0.001).

When the study participants were categorized as per the fitness scale it was observed that more males fell under good and excellent category whereas more females were in average and good category (Table 3).

Result of the study showed negative correlation of BMI (r = -0.339), obesity category (r = -0.275), obese vs non-obese (r = -0.264) and basal pulse rate (r = -0.456) with VO_{2max} and positive correlation of height (r = 0.592) and hours of study (r = 0.309) with VO_{2max}. No correlation was found between weight and VO_{2max}, basal blood pressure and VO_{2max}, academic percentage and VO_{2max} and hours of sleep and VO_{2max}. (Table 4)

DISCUSSION:

The purpose of our study was to assess and compare the effect of various physical and academic parameters on cardio-respiratory fitness in terms of maximum aerobic capacity (VO_{2max}) in adult males and females. The present study showed that the mean value of VO_{2max} for males was significantly higher than for females (p < 0.001) which is similar to other studies.[10,14,15,16]

According to the standard VO_{2max} classification, among 40 male students, three students (7.5%) fell in average group, 25 students (62.5%) fell in good group and 12 students (62.5%) fell in excellent group. Among 40 female students, three students (7.5%) fell in fair group, 27 students

Table 3. Normative data for VO_{2max}

Male		Female	
VO_{2max} category(ml/kg/min)	N (%)	VO_{2max} category (ml/kg/min)	N (%)
Poor (≤24.9)	0	Poor (≤23.9)	0
Fair (25-33.9)	0	Fair (24-30.9)	3 (7.5)
Average (34-43.9)	3 (7.5)	Average (31-38.9)	27 (67.5)
Good (44-52.9)	25 (62.5)	Good (39-48.9)	10 (25)
Excellent (≥53)	12(30)	Excellent (≥49)	0
Total	40 (100)	Total	40 (100)

Table 4. Relationship of different parameters with VO_{2max}.

Parameters	Pearson's Correlation with VO_{2max}	p value
Gender	-0.838**	<0.001
Height	0.592**	<0.001
Weight	0.027	0.815
BMI	-0.339**	0.002
Obesity category	-0.275*	0.013
Obese vs Non-obese	-0.264*	0.018
Basal Pulse Rate	-0.456**	<0.001
Basal SBP	0.193	0.086
Basal DBP	0.020	0.859
Basal PP	0.203	0.071
Basal MAP	0.094	0.406
Academic Percentage	0.032	0.776
Hours of Sleep	0.125	0.270
Hours of Study	0.309**	0.005

**strong correlation, *weak correlation

(67.5%) fell in average group and 10 students (25%) fell in good group. Most of the male students fell under good group while most of the female students fell under average group. Similar study done by Rymbui DB et al. showed those students doing regular exercise fall in and above "good" category and those who do not exercise fall in and below the "fair" category.[17]

Majority of male and female participants were in "normal" category according to BMI. Aerobic capacity of male students was significantly higher compared to that of female. This has been confirmed by correlations between considered variables in male and female participants disregarding their physical activity levels.

The reason for reduced VO_{2max} in female subjects participated in our study may be due to sedentary lifestyle, decreased physical activity, unhealthy lifestyle behaviors, etc. It may also be due to lower muscle mass in females compared to males. More the muscle mass is involved in exercise, greater the contribution of muscle pump to venous return and in turn cardiac output. Increase in regular physical activity or exercise may help in increasing muscle mass as well as VO_{2max}. Therefore, a suggestion to reduce body fat percentage by the help of increased physical activity or exercise would help to decrease health risks in young adults.[18]

There are few limitations of this study. Only adults of age group 18-25 years were taken. A study with different age groups with wide range of BMI may provide a better scenario of relation between the BMI and aerobic capacity. Physical activity of participants were not assessed that may affect performance.

CONCLUSION:

This study showed that non-obese participants have better cardio-respiratory fitness than obese. Females were found to be more obese than males and males had better cardio-respiratory fitness than their female counterparts. Males fell under good and excellent category whereas females fell under average category. Thus, increased BMI was associated with decreased level of VO_{2max} in young adults. One can therefore improve VO_{2max} by maintaining normal BMI which would help us to maintain cardiovascular fitness and reduce risk of cardio-respiratory morbidity and mortality.

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