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Original Article

Assessment of Cardio Respiratory Fitness of Trained and Non-Trained Young Adult Males

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Abstract

Background

Cardio respiratory fitness in terms of maximum oxygen uptake (VO_2 max) reflects the physical fitness of a person. VO_2max determines the capacity of an individual to perform sustained exercise. The present study is to assess and compare the cardiorespiratory fitness in terms of VO_2 max between trained and untrained subjects.

Materials and Methods

This cross-sectional study was conducted on 30 young adult males undergoing physical training for more than 3 months to join British army and age-sex matched 30 non-trained controls. VO_2max was estimated indirectly by following the protocol of Queen's College Step Test (QCT) method.

Results

VO_2 max was found significantly higher in the trained males as compared to non-trained group (68.91± 4.42 vs. 50.31±4.80; p=0.02). On comparison of VO_2 max of our subjects with the standard VO_2 max classification, our trained and non-trained groups fitted into the category of high and average on cardiorespiratory fitness scale respectively.

Conclusion

Physical training improves cardio respiratory fitness by increasing VO_2 max.

Keywords: *Cardio respiratory fitness, Step test, Oxygen consumption*

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Introduction

Cardiorespiratory fitness is the ability of thecardiovascular and respiratory systems to supply adequate oxygen to working muscle for energy production needed during physical training [1]. The gold standard for the measurement of cardiorespiratory fitness is the maximal rate of oxygen consumption (VO_2 max). Queen's College step test (QCT) is the simplest and well-established best indirect method to estimate VO_2 max [2].

VO_2 max is the maximum volume of oxygen that the body can consume during intense, whole-body exercise [3]. It is the best indicator of cardiorespiratory endurance and aerobic fitness.It reflects the physical fitness of an individual having athletic capacity [4]. The rise of one metabolic equivalent (3.5mlO_2/kg/min) in VO_2max is associated with a 10-25% improvement in survival [5]. Increase in VO_2max is the most common method of demonstrating the effect of physical training [6].

Every year, thousands of young males from different regions of Nepal attempt to recruit in British army. The selection process is physically demanding so most youths join the private training centre that provides them necessary trainings. To our knowledge, we have not come across studies on such individuals.Therefore, the purpose of our study is to assess and compare the cardiorespiratory fitness in terms of VO_2max between trained and untrained subjects.

Materials and Methods

This comparative cross-sectional study was conducted from m 3rd November, 2019 to 2nd November, 2020 in the Department of Basic and Clinical Physiology at B.P. Koirala Institute of Health Sciences, Nepal. The ethical approval was obtained from the Institutional Review Committee (IRC). The procedure was fully explained and informed written consent was taken from all the subjects recruited for the study.

The study group consisted of 30 healthy male subjectsundergoing physical training for at least more than 3 months with agesranging from 18 to 23 years. They were selected from Ex British Army Training Center of Dharan by convenience sampling.The control group consisted of 30 age-group matched healthy male subjects who were not involved in any type of exercise.Subjects with major systemic illness, muscular-skeletal injuries and lumbar disc herniationwere excluded from the study. The sample size was calculated from the published data using following formula [17].

$$n = (z_{1-\alpha/2}+z_{\beta})2\sigma^2/(X_1-X_2)^2$$

$$= (1.96 + 0.84)^2 \times 2 \times (6.25)^2 / (58-52)^2$$

$$= 16.927$$

$$= \sim 17$$

Adding 10% for non- response; n=19 in each group Hence, the minimum required sample size was 19. However, a sample size of 30 was taken for the study. A detailed history and clinical examination were performed using standard proforma of all subjects involved in the study. Anthropometric data in term of age, weight, height was noted and Body Mass Index (BMI) was calculated. Before commencement of test the subjects were asked to rest, then all the basal parameters like pulse rate, blood pressure and respiratory rate were measured.

VO_2 max was estimated indirectly by following the protocol of Queen's College Step Test (QCT) method. The step test was performed using a tool of 16.25 inches height. Stepping was done for a total duration of 3 minutes at the rate of 24 steps up per minute which was set by a metronome. After completion of exercise, the carotid pulse rate was measured from the fifth to the twentieth second of recovery period for 15 seconds. Then the 15seconds pulse rate was converted into beats per minute. VO_2 max wascalculated using the internationally accepted McArdle equations:

For males: VO_2max = 111.33 –[0.42 × pulse rate (beats/min)][ml/Kg/min]

The data was first entered into Microsoft Excel worksheet and then statistical analysis was done using SPSS 20.0 version. Independent sample t test was used to compare VO_2 max between trained and untrained subjects.The p value of < 0.05 was considered statistically significant.

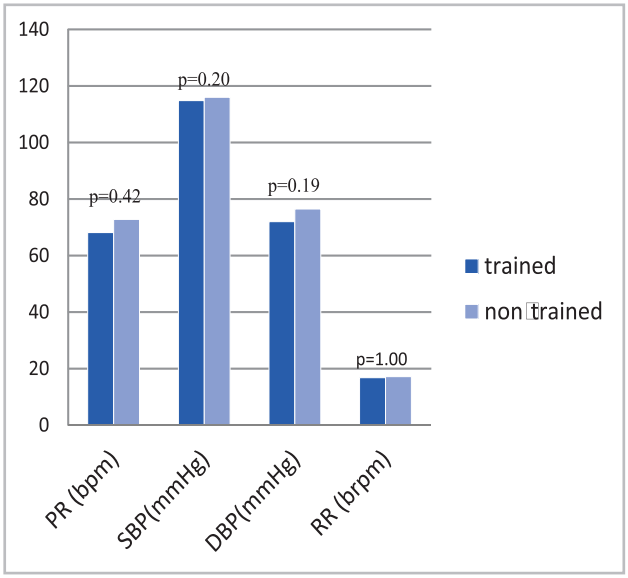
Results

Both the trained and non-trained groups formed a very homogenous population without significant differences concerning their anthropometric and cardiorespiratory variables. Pulse rate was not statistically significant; however was lower (68.17± 3.35 vs. 72.73±1.99) thanthe non-trained groups (Table 1 and Figure 1).

Table 1: Comparison of anthropometric variables between trained and non-trained males

Variables	Trained (n=30); Mean ± SD	Non-trained (n=30); Mean ± SD	p value
Age (years)	18.58±0.90	18.67±1.07	0.57
Weight (Kg)	61.17±4.80	61.42±3.80	0.43
Height (m)	165.67±6.03	167.25±4.41	0.33
BMI (Kg/m²)	22.55±2.47	21.96±1.56	0.72

Kg: kilogram, m: meter: BMI: body mass index, cm: centimeter; p<0.05 = significant



PR: pulse rate, SBP: systolic blood pressure, DBP: diastolic blood pressure, RR: respiratory rate, bpm: beats per minute, mmHg: millimeter of mercury, brpm: breaths per minute

Figure 1: Comparison of cardiorespiratory variables between trained and non-trained males.

The maximal oxygen uptake (VO_2 max) was found significantly higher in the trained subjects incomparison to untrained individuals as shown in Figure 2.

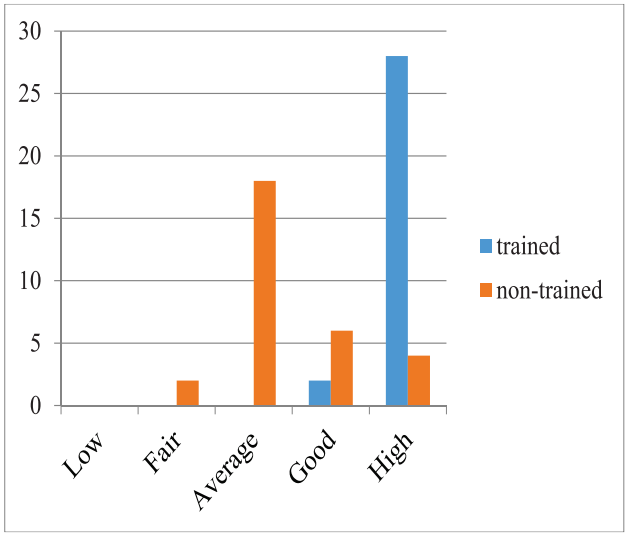


Figure 2: Comparison of VO max between trained and non-trained males.

Figure 3 shows the comparison of VO_2 max of our subjects with the standard VO_2 max classification. Among 30 trained subjects,28 (93.33%) fitted into the high category and 2 (6.67%) into the good category on cardiorespiratory fitness scale. On the other hand, categories of cardiorespiratory fitness scale of non-trained subjects were as follows: 4(13.33%): high, 6(20%): good, 18 (60%): average and 2(6.66%): fair.

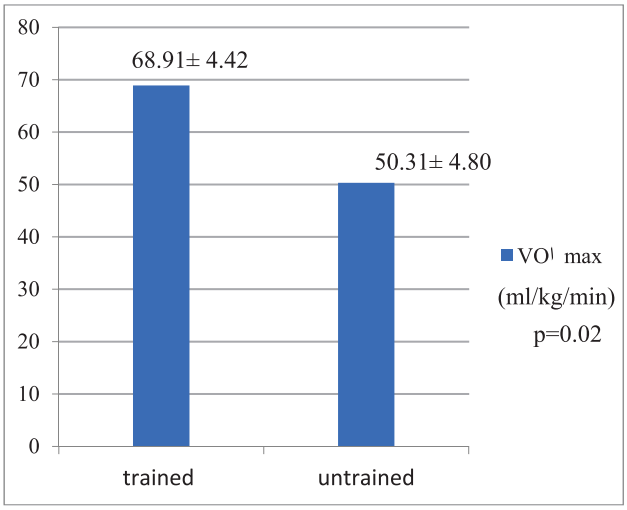


Figure 3: Cardiorespiratory fitness scale based on maximal oxygen consumption (VO_2 max) of trained and non-trained males

Discussion

The maximum oxygen uptake (VO_2 max) is an internationally accepted parameter to evaluate the cardio respiratory fitness. It reflects the amount of oxygen utilized by working muscles during maximal exercise [6]. Therefore, the measurement of VO_2max offers insight into ability of cardiovascular, respiratory and muscular systems to deliver and utilize oxygen [7].

The present study found VO_2 max significantly higher in the trained individuals as compared to non-trained one. The result of our study is found to be consistent with the studies of Mageean et al [8] and Christie CJ et al [9]. Bute et al also reported similar findings. However, their study was carried out in female subjects [3]. Nikolic Z et al suggested that physical training significantly increases maximal aerobic power in young subjects. However, VO_2 max was measured directly during progressive cycle ergometer exercise which differs from our method [7].

Maximal oxygen uptake as a measure of aerobic capacity has been determined as the international standard of physical capacity [10]. Higher VO_2max allows one to produce more energy, thereby performing more work. Regular training increases VO_2max by increasing cardiac output secondary to increase in stroke volume and an increase in arterio-venous oxygen difference [11]. There is ample of evidence that training can improve the performance of muscles by many adaptations, including increased density of the capillary network in the skeletal muscles increasing the capacity to irrigate muscles with blood [12].

Previous studies indicated that training increases the number of mitochondria and enzymes invol-

ved in oxidative metabolism [13]. The net effect is more extraction of O_2 and consequently, for a given work load, less increase in lactate production. In healthy untrained subjects, rapidly increasing lactate levels normally limit exercise tolerance [16]. Less lactate released by the muscles and excess ventilation, together with an increase in the tolerable minute volume, combine to increase the VO_2 max [4]. However, Jacobs et al [14] and MacInniset al[15] suggested that mitochondrial function (i.e. respiration per unit of mitochondria) is not altered in the short-term effect of training. In contrast, mitochondrial function correlates with aerobic capacity in cross-sectional studies indicating a potential long-term effect of training [16].

The findings of better cardiorespiratory fitness of trained individuals in the present study are in agreement with previous study. They suggested that athletes had better lung functions than non-athletes which could be due to better strengthening of respiratory muscle incidental to physical training. Due to regular exercise, athletes tend to have an increase in respiratory capacity [17].The investigation of the maximal oxygen uptake provides the relevant data on the health, planning and follow-up of the training effects. The VO_2max value is also an important indicator of physical capability of athletes for achieving high level of performance [10].

Conclusion

Physical training definitely improves cardiorespiratory fitness by increasing VO_2max that can enhancean individual to achieve high level of performance.

Conflict of interest: None

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