European Journal of Physical Education and Sport Science
ISSN: 2501 - 1235
ISSN-L: 2501 - 1235
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.1210600 Volume 4 │ Issue 2 │ 2018

INFLUENCE OF AEROBIC AND ANAEROBIC EXERCISE ON OXYGEN SATURATION

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Abstract:
The aim of this study was to examine to acute effects of aerobic and anaerobic exercises on oxygen saturation. Twenty three sedentary male subjects were voluntarily participated in the study. Oxygen saturation was measured with four different trials such as before warming up, after warming up, after anaerobic exercise, and after aerobic exercise, acutely. Repeated measures one way ANOVA and LSD correction tests were used for statistical analysis. According to obtained data, oxygen saturation parameter showed statistically changes between trials ($p<0.05$). Especially, after anaerobic trial, oxygen saturation showed significant changes. In conclusion, it could be considered that warm-up, and aerobic exercise does not affect oxygen saturation, however anaerobic exercise has significant effect on it.

Keywords: exercise, acute, oxygen saturation

1. Introduction

The task of the heart and circulatory system is to provide the necessary blood flow and to feed the body tissues and homeostasis. Homeostasis is provided with the transport properties of the blood and metabolic requirements can be met especially with exercise. With exercise, the use of oxygen (O_2) increases in active muscles and more nutrients are needed. The more waste is produced metabolic processes accelerate. Changes must be made in the cardiovascular system to meet these requirements and to adapt (Günay at al., 2008).

The major part of the oxygen in the blood is binds to the hemoglobin (Hb), only 5% are dissolved in the plasma (Wood at al., 2000). In children, the arterial oxygen

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pressure (PaO_2) is 85 mmHg while breathing natural air at the seashore. Oxygen pressure (PvO_2) in the venous blood is 40 mmHg. Molecule hemoglobin binds up to four molecules O_2. Hemoglobin is the rate of saturation with oxygen (Lifton, 1996; Muratlı and Yaman, 1997).

Oxygen is essential to maintain normal life functions in all living organisms except anaerobic microorganisms. Hypoxia, that is, oxygen deficiency, inhibits many biochemical reactions that produce energy at the cell level and ultimately results in death beyond a certain limit (Eneser, 1991).

The purpose of breathing is to provide the oxygen required for oxidation in the organism from the outside environment. Respiration not only helps to remove carbon dioxide which the main metabolic product that results from metabolism, but also positively affects exercise tolerance (Guyton, 1991; Özdal et al., 2017). The balance between delivering and distributing the O_2 to tissue is binds up to the O_2 demand.

Under normal conditions, the changes that occur in the O_2 demand are met by the changes that occur in the supply and distribution of oxygen. Hypoxia occurs when the oxygen demand is greater than the supply (Eneser, 1991).

To oxygenate the tissue, enough oxygen is present in the blood and sufficient Hb concentration is required to carry oxygen. Hb needs to have enough heart flow and oxygen to be transported to the tissues (Langton and Hanning, 1990).

Hypoxia is a word that expresses inadequate oxygenation of tissues. The minimum PO_2 required at tissue level is 20 mmHg for adequate oxygenation with varying tissue to tissue (Eneser, 1991). The most important cause of tissue hypoxia is the inadequate distribution of O_2. This depends on such factors as lung function, heart flow and blood oxygen affinity, and therefore the Hb concentration that determines the oxygen capacity.

Inadequate oxygenation of arterial blood is defined as hypoxia. Hypoxia has two main causes; decrease of alveolar O_2 partial pressure and increase of difference between alveolar-arterial oxygen partial pressures (Marshall, 1972).

Parallel to the fall in oxygen saturation, the pulse accelerates. This affection appears both as stimulation of chemoreceptor and as a response to hypotension due to peripheral vasodilatation, which is caused by hypoxia. This situation caused peripheral and cerebral vasodilatation, increased heart rate and hypotension (Eneser, 1991).

The brain, which consumes 1/5 of the total oxygen consumption of the body, is the most susceptible to oxygen deficiency. Hypoxia is caused to increases brain blood flow, cerebrospinal fluid pressure. Edema develops. Hypotension exacerbates this effect (Singer and Thomas, 1988).

Circulation is one of the main factors affected by exercise and affecting exercise performance. Oxygen saturation is one of important and vital factor of circulation. The aim of this study is to investigate the effect of aerobic and anaerobic exercise on oxygen saturation.

2. Material and Method

Our study was designed according to the trial-controlled cross test design for repeated measurements. Twenty three sedentary male subjects participated in the study in 20-25 age groups (Table 1).

Power analysis was conducted with GPower 3.1 program for determining the number of subjects. Subjects also did not have a nutritional program. For this study, permission was obtained from Gaziantep University Clinical Research Ethics Committee. The subjects visited the lab four times. Each visit was made at the same time of day (16:00-20:00).

- Tests and exercise types to be prescribed in the first visit and voluntary consent forms were obtained.
- On the second visit, the oxygen saturation was measured without warming up and the circulatory parameters were measured again after 10 minutes of general warming.
- At the third and fourth visits, aerobic and anaerobic exercises were performed randomly (by picking the trial card) and then the oxygen saturation was measured. 14 subjects participated in the aerobic exercise at the third visit and 9 subjects participated in the anaerobic exercise at the third visit.
- All the measurements and tests were carried out in the Performance Laboratory of Gaziantep University School of Physical Education and Sports.

Table 1: Descriptive Characteristics

	N	Minimum	Maximum	Mean	Std. Deviation
Age (year)	23	20.00	24.00	22.48	1.16
Height (cm)	23	167.00	188.00	179.13	6.06
Weight (kg)	23	60.00	76.00	70.09	6.38
BMI (kg/m^2)	23	18.41	25.95	21.87	2.07
Anaerobic power (W/kg)	23	9.00	14.67	10.91	1.23
Aerobic power (ml/kg/min)	23	21.73	47.10	31.55	7.50

cm: centimeter, kg: kilogram, W: watt, ml: milliliter, min: minute

2.1. Acute Exercise Protocols

2.1.1. Aerobic exercise protocol

The aerobic exercise protocol applied to the subjects was performed via a bicycle (My Bike 450F, Ergosana GMBH, Bitz, Germany) and an ergospirometer (Ergo100 PFT Systems, Medical Electronic Construction R & D, Brussel, Belgium).

At the beginning of the exercise, the pedal load was determined to be 50W and the exercise was continued by increasing 25W every minute. During the exercise, the subjects followed the screen and tried to pedal at 60 revs / min. Exercise is terminated when the subject decides that he can no longer continue (Özdal, 2015).

2.1.2. Anaerobic exercise protocol

Wingate test protocol was applied for the purpose of acute anaerobic exercise trial. Subjects were weighed with an electronic scale before exercise and 7.5% of their body weight was placed on mechanism. The subject started to exercise by pressing the button when he wanted. With the beginning of the exercise the subject was spoken orally motivated so that he could continue his performance. After the time was complete, the test was terminated and the subjects were continuing to pedal for cool down (Özdal, 2015).

2.2. Oxygen saturation measurement

Oxygen saturation measurements were conducted using a pulse oximeter. For this reason, in our study values will be referred to as SpO2. The oximeter probe was cleaned prior to each measurement. To prevent erroneous, measurements have been carried out in a bright environment. Therefore, fluorescent lumps were used. Prior to the measurements, the subjects were informed about the test. Each subject was rested at the beginning of the measurement and the oximeter probe was placed on the index fingers in a position where they could sit comfortably. Each measurement was taken for 1 minute (Hakverdioğlu, 2007; Anderson at al., 2002).

2.3. Statistical Method

SPSS 22.0 program was used for statistical processing. After the normality and homogeneity testing, one-way analysis of variance and LSD correction were performed for repeated measurements. Values were presented as minimum, maximum, mean, standard deviation, standard error, and upper-lower 95% confidence interval and a significance level was determined as 0.05.

3. Result

Table 2 presents the analysis of the change in oxygen saturation between trials. In repeated measures were conducted; as a result of one-way analysis of variance, there was a significant difference between the oxygen saturation results measured after anaerobic exercise and the oxygen saturation results before and after warming and after aerobic exercise.

Table 2: Analysis of the change in oxygen saturation (%) between trials

	Mean±SD	Std. E.	%95 CI		F	p	Difference
			Lower	Upper			
Pre warming	97.52±1.65	0.34	96.81	98.23	5.737	0.003	1-3 2-3 4-3
Post warming	97.52±3.13	0.65	96.17	98.88			
After anaerobic exercise	95.13±2.93	0.61	93.86	96.40			
After aerobic exercise	97.22±2.04	0.43	96.33	98.10			

SD: standard deviation, CI: confidence interval

As seen in figure 1, the oxygen saturation remained within normal limits before and after warm-up and after aerobic exercise and very closes results. However, there was a considerable decrease in result of the anaerobic exercise.

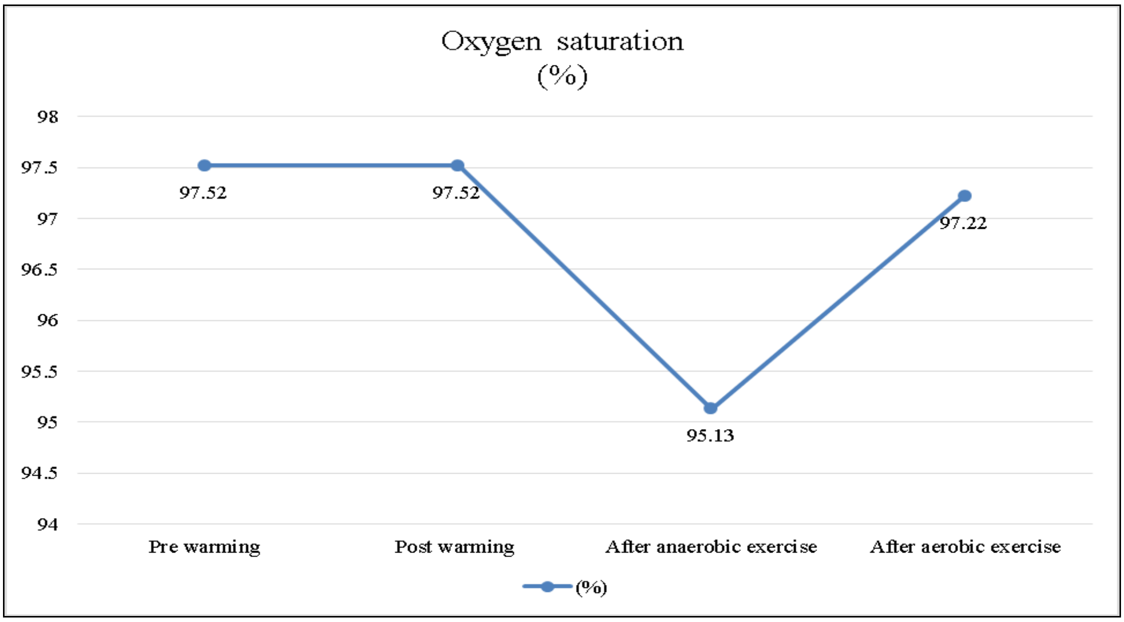

Figure 1: Change of oxygen saturation between trials

4. Discussion and Conclusion

The aim of this study was to determine the acute effects of aerobic and anaerobic exercises on oxygen saturation.

In this study, two warming treatments were carried out to be before and after warming, and the oxygen saturation was measured separately. Measurements made prior to warming were evaluated in terms of control in order to demonstrate the effect of warming.

The mean of the subjects before warming up in the oxygen saturation parameter was 97.52 ± 1.65%, after warming oxygen saturation was measured at 97.52 ± 3.13%. It was detected that the oxygen saturation values measured before and after warming were not different ($p > 0.05$).

It was found that the oxygen saturation decreased to 95.13 ± 2.93% after anaerobic exercise and this result was significantly different from the measured oxygen saturation value before and after warming ($p < 0.05$).

Fluck and colleagues examined the effect of warming on oxygen saturation in their study conducted in 2003 and did not see any statistical difference (Fluck at al., 2003).

Harris and colleagues examined that the responses to hypoxic conditions during exercise in their study in 2013. They did not notice a difference in oxygen saturation during the warm-up, but they found a decrease in oxygen saturation during the increased severity of the exercise (Harris at al., 2013).

It can be assumed that as the reason why oxygen saturation values did not change is caused by the fact that it does not occur significant changes in homeostasis because warming does not an effective physical activities.

4.1. Acute effect of anaerobic exercise on oxygen saturation

In the oxygen saturation parameter, the mean of the subjects after anaerobic exercise was measures as 95.13 ± 2.93%. In this respect, there was a significant difference between oxygen saturation measurements before warming, after warming and after aerobic exercise ($p < 0.05$).

Campbell and colleagues reported in the study conducted in 2009 that oxygen saturation with intense exercise was significantly lower than the resting value (Campell at al., 2009).

In our study, oxygen saturation was affected by anaerobic exercise. In addition, the respiratory system can meet required oxygen increased during Wingate exercise in 30 sec. this situation can explain that minimal but significant decreasing in oxygen saturation.

It can be proved that the fall in oxygen saturation that with an increase in heart rate, despite the increased amount of blood in the pulmonary circulation, insufficient time for adequate gas diffusion may be the cause of the decreasing in oxygen saturation.

4.2. Acute effect of aerobic exercise on oxygen saturation

In our study, ergospirometer and ergoline bike were used for aerobic exercise. Immediately after exercise, oxygen saturation was measured and compared with other trials.

After aerobic exercise, the average of oxygen saturation parameter was measured as 97.22 ± 2.04%. In these respect, there was a significant differences between oxygen saturation measured after anaerobic exercise and anaerobic exercise trial ($p<0.05$).

Rowell et al. reported that oxygen saturation was influenced by maximal exercise but it was not change on aerobic-based exercise in their study of oxygen saturation changes during and after exercise (Rowell at al., 1964).

Kanstrup and Ekblom stated that oxygen saturation was not affected acutely by exercise. However, they reported that acute changes could be observed depending on severity (Kanstrup and Ekblom, 1982).

In the present study, oxygen saturation was not affected by aerobic exercise. It can be showed that as the reason oxygen saturation was close to the rest level, the exercise severity did not sudden and extreme and compatibility between respiratory and circulatory system (steady state). Therefore, it was not necessary to change on the oxygen saturation.

In summary, it can be said that warm-up, aerobic exercise does not acutely affect oxygen saturation, while anaerobic exercise do.

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