PRINT: ISSN 0972-0073 ONLINE: ISSN 2456-6802
Anthropologist, 19(1): 87-93 (2015)
DOI: 10.31901/24566802.2015/19.01.10

The Effects of Acute Aerobic and Anaerobic Exercise on Blood Parameters

Tulin Atan[1] and Hasan Alacam[2]

[1]University of Ondokuz Mayýs, Faculty of Yasar Dogu Sports Sciences, Samsun, Turkey
[2]University of Ondokuz Mayýs, Faculty of Medical, Samsun, Turkey
E-mail: [1]<takman@omu.edu.edu>, [2]<hasanalacam@hotmail.com>

KEYWORDS Exercise. Erythrocyte. Leukocyte. Thrombocyte. Hematocrit

ABSTRACT The study attempts to investigate the effect of acute aerobic and anaerobic exercise on blood parameters and to determine whether blood parameters change between aerobic and anaerobic exercise. To achieve the objectives of this study, 25 male athletes participated in the research. Aerobic (Shuttle run test) and anaerobic (Running aerobic) Sprint test (RAST) exercise test were applied to the test subjects with a one-week interval. Before the exercise (resting), 1 minute and 60 minutes after both exercises' protocol, subjects' blood samples were taken to determine the blood hematologic values. A rise in the values was observed in 1 minute after the exercise, but 60 minutes after the exercise it was observed that most of the hematologic parameters returned to the resting levels. It was found out that the effect of aerobic and anaerobic exercise on hematologic blood parameters was mostly similar.

INTRODUCTION

With the development of cardiovascular function, and the changes in body composition and blood pressure, regular physical exercise can make the organism more resistant to daily life problems (Uz 2011). Heavy exercise is regarded as one of the strongest stress factors which the organism can face. The body system can react against this stress by displaying some changes in metabolic, hormonal and immune system (Shephard and Shek 1998). One of these changes is the change in blood (Hazar and Yilmaz 2008). Blood volume changes are an important adaptation to exercise training (Hu and Lin 2012).

The most significant impact of regular exercise is on blood cells (Buyukyazi and Turgay 2000). There are different findings related to blood biochemistry level depending on the exercise. The adverse effects of acute exercise on blood circulation is displayed with the increase in hematocrit, blood flow velocity, plasma viscosity and erythrocyte rigidity and the decrease in the sedimentation after the exercise (Ajmanni et al. 2003). In addition to the studies which suggest that as a result of an acute exercise, positive development occurred in blood lipid and hematologic levels, but there are some other studies showing that there is no difference.

Objectives

The objective of this study was to determine the effect of both acute aerobic exercise and acute anaerobic exercise on some blood values. The result of the research will provide trainers, athletes and conditioners with useful information.

MATERIAL AND METHODS

The data consist of twenty-five (25) male athletes between the age: 22.43±2.25 years; sports age: 8.50±3.32 years; height:178.11±7.23 cm; body weight: 76.16±10.11 kg) who study at the faculty of Sports Science participated in this study. Research procedures were approved by the Ethics Commission of the University of *Ondokuz Mayýs* and this study was carried out in accordance with the principles of the 2008 Helsinki Declaration. The participants gave their written informed consent to participate. Furthermore, this study was supported by *Ondokuz Mayis* University's Scientific Research and Development Support Program Project. Aerobic exercise test (shuttle run test) and anaerobic exercise test (Running Anaerobic Sprint test (RAST) were applied to the subjects with a one-week interval. The participants implemented the protocol of both exercises; however, which test would be held first was determined randomly. 12 of the athletes did aerobic exercise first whereas the 13 of them did anaerobic exercise. One week later, the ones who did aerobic exercise one week ago did anaerobic exercise and the others who did anaerobic exercise one week ago did aerobic exercise. Before the exercise (resting) and 1 and 60 minutes after both exercises

protocol, the blood values were examined. The following blood values were studied:

Hematologic Value (Complete Blood Count)

RBC (erythrocyte), hemoglobin, hematocrit, MCV (average erythrocyte volume), MCH (amount of hemoglobin in erythrocytes), MCHC (average erythrocyte hemoglobin concentration), RDW (erythrocyte distribution width of red blood cells), WBC (leukocyte), Lymphocyte, Monocyte, Neutrophile, Eosinophil, Basophil, PLT (platelet), MPV (average platelet volume), PDW % (thrombocyte distribution width), PCT % (what percent of the blood thrombocyte account for).

Blood Measurements

Blood sample was drawn by the doctor and a specialist nurse. The samples of blood collected were transferred separately into the dry tubes which contained anticoagulant and into the ones that do not contain it from the injector. The blood samples put into the tubes which do not contain anticoagulant were kept for clotting. After these samples clotted, their serums were separated by doing centrifuge in 3000 rpm for 10 minutes and these separated samples were kept at a Celsius degree of 80 below zero. Blood parameters were studied at the central laboratory of Medicine Faculty at Ondokuz Mayis University.

Height of the Subjects

It was measured by a scale with 1cm spaced leaned to the wall.

Body Weight Measurements

They were measured by a ground-scale while the subjects are wearing shorts with bare feet.

Test Procedure

The participants were warned not to engage in mild or heavy exercise, not to take alcohol and stimulants**,** and were advised to care for their diet and rest within 24 hours before the test.

20m Shuttle Run Test

It was used to ensure aerobic fatigue. For this aim New Test-Power Timer 1.9.5. (Newtest, Oulu, Finland) brand instrument was used. This test involves continuous speed between two lines 20m apart in time to recorded beeps. The athletes stand behind one of the lines facing the second line, and began running as instructed by the recorder. Initial running velocity was 8.5 km/hr, and velocity increased to 0.5 km/hr in each minute. The athletes continued the running process between the two lines, turning when signaled by the recorded beeps. If the line is not reached before the beep sounds, the subject is given a warning and must continue to run to the line, then turn and try to catch up with the pace within two more 'beeps'. The test is stopped if the subject fails to reach the line (within 2 meters) for two consecutive ends after a warning.

Running-based Anaerobic Sprint Test (RAST)

The measurements were taken by *Newtest Powertimer* (Finland). Each subject warmed up for a period of five minutes which was followed by a five-minute passive recovery. The athlete completes six 35-me-tre runs at maximum pace with 10 seconds allowed between each sprint for turnaround (Draper and Whyte 1997).

Statistical Analysis

The data obtained from the research were analyzed in SPSS version 19.0 package program. All values are expressed in means ± standard deviation. Paired t test, re-peated measures analysis of variance test and Bonferroni comparison test were used for the statistical analysis.

RESULTS

In Table 1, erythrocyte parameters which were measured before and 1 and 60 minutes after the exercise were displayed. It was seen that many erythrocyte blood parameters (RBC, Hemoglobin, Hematocrit, MCV) measured 1 minute after the exercise increased compared to the ones before exercise ($p<0.01$). It was discovered that above-mentioned blood parameters which were measured 60 minutes after the exercise were lower than the values measured 1 minute after the exercise ($p<0.01$ and $p<0.05$).

It was observed that MCHC value 1 minute after both aerobic and anaerobic exercise decreased compared to the one before the exercises ($p<0.01$). It was discovered that MCHC value measured 60 minutes after the exercise was high-

Table 1: Erythrocyte parameters for aerobic and anaerobic exercise

Blood parameters	*Measurement times*	*Aerobic exercise*		*Anaerobic exercise*		*Comparison of aerobic and anaerobic exercise*
		Mean± Standard deviation	*p*	*Mean± Standard deviation*	*p*	*p*
RBC (million/uL)	Pre-exercise (1)	4.80±0.32	2>1,3	4.93±0.31	2>1,3**	0.132
	1min after exercise (2)	5.00±0.27		5.12±0.33		0.376
	60min after exercise (3)	4.74±0.28		4.84±0.35		0.564
Hemoglobin (g/dl)	Pre-exercise (1)	14.40±0.84	2>1,3**1>3*	14.94±0.78	2>1,3**1>3*	0.059
	1min after exercise (2)	15.13±0.87		15.57±0.70		0.118
	60min after exercise (3)	14.13±0.70		14.58±0.75		0.135
Hematocrit (%)	Pre-exercise (1)	43.23±2.37	1>3**2>1,3**	44.13±1.92	2>1,3**1>3*	0.114
	1min after exercise (2)	46.55±2.19		47.92±2.18		0.101
	60min after exercise (3)	42.35±2.10		43.06±2.25		0.423
MCV (fL)	Pre-exercise (1)	90.09±3.84	1>3**2>1,3**	89.64±4.21	2>1,3**1>3*	0.743
	1min after exercise (2)	93.21±3.97		93.64±4.19		0.020*
	60min after exercise (3)	89.40±3.80		89.13±4.27		0.134
MCH (pg)	Pre-exercise (1)	30.02±1.57	2>3*	30.32±1.39	-	0.919
	1min after exercise (2)	30.33±1.48		30.40±1.44		0.520
	60min after exercise (3)	29.84±1.57		30.17±1.37		0.132
MCHC (g/dL)	Pre-exercise (1)	33.33±0.67	2<1,3**	33.84±0.86	2<1,3**	1.000
	1min after exercise (2)	32.53±0.97		32.48±0.74		0.429
	60min after exercise (3)	33.41±0.73		33.86±0.56		0.253
RDW (%)	Pre-exercise (1)	13.64±0.51	2>1**2>3*	13.44±0.55	-	0.078
	1min after exercise (2)	13.73±0.53		13.48±0.55		0.040*
	60min after exercise (3)	13.58±0.48		13.45±0.46		0.337

*p<0.05 **p<0.01

er than the value measured 1 minute after it (p<0.01).

It was detected that when erythrocytary parameters were compared between aerobic and anaerobic exercises, resting values were not different between both exercises (p>0.05). MCV value measured 1 minute after two different exercises was discovered to be higher after anaerobic exercise compared with aerobic exercise (p<0.05) RDW values measured 1 minute after the exercise were found out to alter between aerobic and anaerobic exercises. RDW value after aerobic exercise was found to be higher than the value after anaerobic exercise (p<0.05). It was discovered that either 1 minute or 60 minutes after the exercise , no other erythrocytary parameters (RBC, hemoglobin, hematocrit, MCH, MCHC) showed difference between two exercises (p>0.05).

In Table 2, leukocytic parameters which were measured before and 1 and 60 minutes after the exercise were displayed. It was observed that many leukocytic blood parameters (WBC, lymphocyte (%), lymphocyte, monocyte (%), monocyte, eosinophil and basophil) measured 1 minute after the exercise increased compared to the ones before exercise (p<0.01) These blood parameters which were measured 60 minutes after the exercise were discovered to be lower than the values measured 1 minute after the exercise (p<0.01 and p<0.05).

It was discovered that Neutrophile (%) value 1 minute after the both exercise was lower compared to the one before exercise (p<0.01), but 60 minutes after the exercise, the value was higher than the one both before the exercise and 1 minute after it (p<0.01). And also Eosinophil (%) value measured 1 minute after the both exercise was discovered to decrease compared with the one before the exercise (p<0.01).

WBC, Monocyte, Basophil (%) and Basophil values were found not to show meaningful difference between prior to the exercise and 60 minutes after it (p>0.05). However, Lymphocyte (%), lymphocyte and Eosinophil values were discovered to show difference prior to exercise and 60 minutes after the exercise (p<0.01).

When leukocytic parameters were compared between aerobic and anaerobic exercises, the values taken before exercises were observed to show no difference between two exercises (p>0.05). When the leukocytic parameters 1 minute after the exercise were compared, lymphocyte and monocyte values differ between

Table 2: Leukocytic parameters for aerobic and anaerobic exercise

Blood parameters	*Measurement times*	*Aerobic exercise*		*Anaerobic exercise*		*Comparison of aerobic and anaerobic exercise*
		Mean± Standard deviation	*p*	*Mean± Standard deviation*	*p*	*p*
WBC	Pre-exercise (1)	6.18±1.30	2>1,3**	6.28±1.20	2>1,3**	0.973
(thousand/uL)	1min after exercise (2)	10.58±2.69		9.52±1.60		0.062
	60min after exercise (3)	6.50±1.78		6.00±1.62		0.137
Lymphocyte	Pre-exercise (1)	34.31±6.14	1>3**2>1,3**	35.24±7.49	2>1,3**1>3**	0.491
(%)	1min after exercise (2)	44.96±5.73		44.11±7.31		0.620
	60min after exercise (3)	23.83±5.55		25.58±6.05		0.176
Lymphocyte	Pre-exercise (1)	2.08±0.39	1>3**2>1,3**	2.17±0.46	2>1,3**1>3**	0.483
(thousand/uL)	1min after exercise (2)	4.70±1.13		4.17±0.90		0.030*
	60min after exercise (3)	1.48±0.29		1.49±0.42		0.855
Monocytes	Pre-exercise (1)	6.39±1.50	3<1,2*	6.35±0.92	-	0.321
(%)	1min after exercise (2)	6.41±1.20		6.31±1.09		0.548
	60min after exercise (3)	5.68±1.58		6.02±1.12		0.196
Monocytes	Pre-exercise (1)	0.39±0.09	2>1,3**	0.41±0.11	2>1,3**1>3*	0.373
thousand/uL)	1min after exercise (2)	0.67±0.18		0.60±0.14		0.034*
	60min after exercise (3)	0.35±0.10		0.36±0.11		0.693
Neutrophil (%)	Pre-exercise (1)	53.21±8.61	1<3**2<1,3**	52.16±8.98	1<3**2<1,3**	0.381
	1min after exercise (2)	41.70±7.43		42.65±8.03		0.657
	60min after exercise (3)	65.94±7.86		63.15±7.64		0.086
Neutrophil	Pre-exercise (1)	3.35±1.12	1<2,3**	3.32±1.00	1<2**1<3*	0.699
(thousand/uL)	1min after exercise (2)	4.48±1.66		4.09±1.17		0.291
	60min after exercise (3)	4.38±1.62		3.84±1.30		0.105
Eosinophil	Pre-exercise (1)	3.19±1.90	1>2,3**	3.40±2.26	1>2**1>3*	0.368
(%)	1min after exercise (2)	2.59±1.46		2.70±1.59		0.632
	60min after exercise (3)	2.21±1.41		2.84±1.88		0.000**
Eosinophil	Pre-exercise (1)	0.18±0.09	2>1,3**1>3**	0.20±0.13	2>1,3**1>3**	0.179
(thousand/uL)	1min after exercise (2)	0.25±0.12		0.25±0.14		0.342
	60min after exercise (3)	0.13±0.07		0.16±0.10		0.055
Basophil (%)	Pre-exercise (1)	0.56±0.26	2>3*	0.64±0.29	2>3**	0.547
	1min after exercise (2)	0.62±0.18		0.70±0.22		0.474
	60min after exercise (3)	0.49±0.26		0.57±0.20		0.916
Basophil	Pre-exercise (1)	0.03±0.01	2>1,3**	0.05±0.07	2>3**	0.595
(thousand/uL)	1min after exercise (2)	0.06±0.02		0.06±0.02		0.089
	60min after exercise (3)	0.03±0.01		0.03±0.01		0.553

*p<0.05 **p<0.01

aerobic and anaerobic exercises (p<0.05); however, other leukocytic parameters did not indicate any difference between two exercises (p>0.05). When the leukocytic parameters measured 60 minutes after the exercise were compared, it was discovered that only Eosinophil (%) value showed meaningful difference between the two exercises (p<0.01), while other parameters did not show any variations (p>0.05).

In Table 3, thrombocyte parameters which were measured before and 1 and 60 minutes after the exercise were displayed. It was observed that many thrombocyte blood parameters (PLT, MPV, PCT) measured 1 minute after both aerobic and anaerobic exercise increased compared to the one before the exercises (p<0.01).

When thrombocyte parameters were compared between aerobic and anaerobic exercises, the values prior to the exercise and the values 1 and 60 minutes following the exercises were observed to show no difference between the two exercises (p>0.05).

DISCUSSION

In this study, the changes in blood hematologic parameters following aerobic and anaerobic exercises were studied and whether the two different exercises have different effects on hematologic parameters was investigated.

In this study, erythrocytary parametres measured before exercise and measured 1 and 60 minutes after it were compared. It was observed that many erythrocytary parameters (RBC, Hemoglobin, Hematocrit, MCV) measured 1 minute after the exercise increased compared to the ones be-

Table 3: Thrombocyte parameters for aerobic and anaerobic exercise

Blood parameters	*Measurement times*	*Aerobic exercise*		*Anaerobic exercise*		*Comparison of aerobic and anaerobic exercise*
		Mean± Standard deviation	*p*	*Mean± Standard deviation*	*p*	*p*
PLT (thousand/uL)	Pre-exercise (1)	236.05±38.17	2>1**2>3*	238.09±41.46	2>1,3*	0.139
	1min after exercise (2)	281.78±59.19		265.40±64.26		0.516
	60min after exercise (3)	254.57±41.61		236.86±49.54		0.236
MPV (fL)	Pre-exercise (1)	8.55± 0.86	2>1,3**	9.05± 0.85	2>1,3**	0.171
	1min after exercise (2)	9.03± 0.78		9.57± 0.85		0.075
	60min after exercise (3)	8.16± 0.65		8.76± 1.06		0.180
PCT (%)	Pre-exercise (1)	0.20± 0.02	2>1,3**	0.21± 0.03	2>1,3**	0.207
	1min after exercise (2)	0.25± 0.05		0.25± 0.05		1.000
	60min after exercise (3)	0.19± 0.05		0.20± 0.03		0.553
PDW (%)	Pre-exercise (1)	55.26± 9.31	-	53.38± 5.13	-	0.099
	1min after exercise (2)	50.76± 6.11		52.91± 5.70		0.689
	60min after exercise (3)	53.26± 9.13		53.75± 6.96		0.316

*p<0.05 **p<0.01

fore the exercise. Lippi et al. (2014) studied 31 middle-trained athletes (mean training regimen 217 ± 32 min/week) who performed a 21.1 km, half-marathon run. Blood samples were collected before the run, at the end, and 3 and 20 hours thereafter. The MCV significantly increased at the end of running and returned to baseline 3 hours, thereafter, (Lippi 2014). In this study, 1 minute after both aerobic and anaerobic exercises, MCHC value was observed to decrease compared with the level before the exercise. However, 60 minutes after the exercise, it was viewed to return back to the resting level. Kandi et al. (2013) investigated the effect of maximal exercise session in the morning and the afternoon on certain hematological factors. Blood samples were collected from both groups before, immediately after, and 2 hours after the exercise. They found significant differences in the levels of hemoglobin and erythrocytes at different stages of blood sampling. Further, no difference was observed in the level of hemoglobin and erythrocytes before and two hours after the exercise as this study. Since, the amount of blood plasma goes down during the exercise, hemoglobin, hematocrit and red blood cells increase (Sawka et al. 2000; Gun 1991). This increase is temporary because blood parameters turn back to normal levels during the resting (Gun 1991). This situation explains the rise in blood parameters 1 minute following the exercise.

In this study, when erythrocytary parameters were compared between aerobic and anaerobic exercises, it was found out that MCV value measured 1 minute after the exercise is higher after anaerobic exercise compared with aerobic exercise. RDW values which were measured 1 minute after the exercise were detected to differ between aerobic and anaerobic exercises. It was found that RDW value after aerobic exercise was higher when compared with anaerobic one. It was discovered that either 1 minute or 60 minutes after the exercise no other erythrocytary parameters (RBC, hemoglobin, hematocrit, MCH, MCHC) showed difference between two exercises. The reason for this situation could be that shuttle run test duration, which is used in aerobic exercise, is also short although it is not as short as RAST test duration.

In this research, while RBC values before aerobic and anaerobic exercises were found 4.80±0.32 million/uL and 4.93±0.31 million/uL respectively, they were found as 5.00±0.27 million/uL and 5.12±0.33 million/uL 1 minute after aerobic and anaerobic exercises and 4.74±0.28 million/uL and 4.84±0.35 million/uL 60 minutes after the two exercises respectively. It was discovered that either 1 minute or 60 minutes after the exercise, RBC values did not show any differences between aerobic and anaerobic exercises. RBC values, 1 minute after both aerobic and anaerobic exercises, became higher compared to the ones before the exercise, but after 60 minutes those values were seen to turn back to previous levels. These increases were reported to be dependent on plasma loss caused by exercise (Londeann 1978). It seemed that some studies supported this finding (Unal et al. 2001; Bezci and Kaya 2010; Ercan et al. 1996). Unal et al. (2001) discovered that there was an increase in RBC

levels 30 minutes after aerobic exercise. In a study by Bezci and Kaya (2010), erythrocyte levels of females doing taekwondo were examined and a meaningful increase happened in the erythrocyte levels of athletes as a result of acute activity. It was found that while RBC values were 4.40 before exercising, this value increased to 4.50 after the exercise (Bezci and Kaya 2010). Ercan et al. (1996), again, reported that erythrocyte levels of participants showed meaningful increase after 3000-metre long time resistance run compared to the level before the run. In their study, erythrocytary parameter increase is explained by hemoconcentration mechanism.

In this study, leukocytic parameters measured before and 1 and 60 minutes after the exercise were compared. It was discovered that compared with the ones before the exercise, only neutrophile (%) and eosinophil (%) values decreased 1 minute after exercising ($p<0.01$), but many other leukocytic parameters (WBC, lymphocyte (%), lymphocyte, monocyte (%),monocyte, neutrophile, eosinophil and basophil) increased.

It was discovered from this study, that WBC, Monocyte, Basophil (%) and Basophil values which increased 1 minute after exercising turned back to the level before the exercise after 60 minutes of exercise. Yet lymphocyte (%), lymphocyte and Eosinophil values increasing 1 minute after exercise fell down even below the level of resting 60 minutes later. Alibeyoglu (2008) found that lymphocyte (%) values indicated a decrease in the first hour after exercising. It was discovered that in our study, neutrophile (%) value went down 1 minute after exercise; it increased 60 minutes later and even this increase was above the resting level.

Through this study, it has been discovered that that the results of this study were paralleled with those of the studies conducted before (Kappel 1998; Green et al. 2003). Kappel et al. (1998) found meaningful increase in the number of leucocyte after exercise during the acute training they applied to sedentary group. Further, in another study, an important rise in leucocytes was found as a result of 60-minute acute exercise practice (Beydagi et al. 1994).

In this study, when leukocytic parameters were compared between aerobic and anaerobic exercises, lymphocyte and monocyte values showed difference between aerobic and anaerobic exercises ($p<0.05$), while other leukocytic parameters did not indicate any variance between the two exercises ($p>0.05$). It was determined that monocyte values increased 1 minute after both exercises ($p<0.01$), and it was observed that this increase was more after aerobic exercise compared to anaerobic exercise ($p<0.05$). Eosinophil (%) value fell down 1 minute after both exercises, but while this decrease went on 60 minutes after aerobic exercise, it started to increase 60 minutes after anaerobic exercise. Therefore, eosinophil (%) value showed difference between aerobic and anaerobic exercises 60 minutes after exercising.

It was observed in the study that there were notable increases in the levels of thrombocyte 1 minute after exercising, and 60 minutes after it, it turned back to the levels before exercise. In the study of Lippi et al. (2014), the platelet count and MPV both increased after the run and returned to baseline 3 hours thereafter as this study (Lippi 2014). Beydagi et al. (1994) pointed out that although the increase in hematologic parameters was seen just after exercising, it turned back to resting level 24 hours after the exercise. The result of this study shows parallelism with this research.

CONCLUSION

In this study, it was discovered that there was an increase in hematologic values one minute after exercising, but 60 minutes after the exercise, it was established that most of the hematologic parameters returned to the levels prior to exercise. It was found that the effect of aerobic and anaerobic exercise on hematologic blood parameters was similar except for several parameters.

RECOMMENDATIONS

The effect of aerobic and anaerobic exercises on different blood parameters (such as hormone levels) can be included in future studies, and effect of different type of exercise on health should be investigated.

ACKNOWLEDGEMENTS

This study was supported by *Ondokuz Mayýs* University's Scientific Research and Development Support Program Project. Thanks for the support.

REFERENCES

Alibeyoglu A 2008. *Investigation of Serum Enzymes and Hematological Changes in Young Man after Acute Endurance Exercise*. Master Thesis, Unpublished. Kars: Kafkas University, Institute of Health Sciences.

Ajmani RS, Fleg JL, Demehin A et al. 2003. Oxidative stress and hemorheological changes induced by acute treadmill exercise. *Clin Hemorheol Microcirc,* 28: 29-40.

Beydagi H, Çoksevim B, Temocin S 1994. Effects of exercise on red blood cell parameters in groups who engaged and who do not engaged in sports. *Journal of Gaziantep University Faculty of Medicine,* 5: 21-28.

Bezci S, Kaya Y 2010. The analysis of hematological parameters of elite women taekwondoers before and after training. *Pamukkale Journal of Sport Sciences,* 1(2): 1-16.

Buyukyazi G, Turgay F 2000. Acute and chronic effects of continuous and extensive interval running exercises on some hematological parameters. *Turkish Journal of Sports Medicine,* 35(3): 103-113.

Draper N, Whyte G 1997. Here's a new running based test of anaerobic performance for which you need only a stopwatch and a calculator. *Peak Perform,* 97: 3-5.

Ercan M, Bayiroglu F, Kale R et al. 1996. Effects of long-term running exercise on some blood parameters. *Turkish Journal of Sports Medicine,* 31(2): 73–80.

Gun C 1991. *Comparison of Ergometric Performance Level of 8-10 and 11-13 Years of Age Group Swimmers.* Master Thesis, Unpublished. Institute of Health Sciences. Istanbul: Istanbul University.

Green KJ, Rowbottom DG, Mackinnon LT 2003. Acute exercise and T-lymphocyte expression of the early activation marker CD69. *Med Sci Sports Exerc,* 35(4): 582-588.

Hazar S, Yilmaz G 2008. *Acute Effect of Submaximal Treadmill Exercise on Immune System.* Bolu: 10th International Sports Science Congress Book, pp. 23-25.

Kandi YMNP, Kandi AMNP, Shahidi F, Masoudian B 2013. The effect of a maximal aerobic exercise session in the morning and afternoon on certain hematological factors in young athletes. *RJMS,* 20(106): 20-29.

Kappel M, Poulsen T, Galbo H et al. 1998. Effect of elevated noradrenaline concentration on the immune system in humans. *Eur J Appl Physiol,* 79: 93-98.

Londeann R 1978. Low hematocrits during basic training: Athlete's anemia. *N Engl J Med,* 299: 1191-1192.

Ozdengil F 1998. *The Effects of Acute Submaximal Exercise on Immune System*. PhD Thesis, Unpublished. Institute of Health Sciences, Department of Physiology. Konya: Selcuk University.

Sahlin K, Ekberg K, Cizinsky S 1991. Changes in plasma hypoxanthine and free radical markers during exercise in man. *Acta Physiol Scand,* 145: 275-281.

Sawka MN, Convertino VA, Eichner ER et al. 2000. Blood volume: Importance and adaptations to exercise training, environmental stresses, and trauma sickness. *Medicine and Science in Sports and Exercise,* 32(2): 332-348.

Shephard RJ, Shek PN 1998. Immune responses to inflammation and trauma: A physical training model. *Can. J. Physiol Phermacol,* 76: 469-472.

Shumantel LB, Brooke MH, Carroll JE et al. 1979. Increased serum creatine kinase after exercise: A sex linked phenomenon. *Neurology,* 29: 902-904.

Uz A 2011. *To Investigate the Effects of Acute Exercise on the Heart Tissue.* Master Thesis, Unpublished. Institute of Health Sciences, Department of Pharmacy Biochemistry. Kayseri: Erciyes University.

Unal M, Erdem S, Kayserilioglu A et al. 2001. The effect of aerobic and anaerobic acute exercises on the immune parameters. *Journal of the Istanbul Faculty of Medicine,* 64(3): 174-181.

Zergeroglu AM, Ersöz G, Yavuzer S 1999. Erythrocyte antioxidant enzyme activity following supramaximal and incremental exercises in sedentary man. *Turkish Journal of Sports Medicine,* 34: 65-71.