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European Journal of Experimental Biology, 2013, 3(1):559-563

ISSN: 2248 –9215
CODEN (USA): EJEBAU

The comparison of blood parameters between morning and evening exercise

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ABSTRACT

The purpose of this study was to research to the differences of blood parameters between morning exercise and evening exercises. 12 participants, in younger adults aged 20 years, were recruited and their blood was taken four times, from 8:00 to 9:00 (pre and post) for morning exercise and from 20:00 to 21:00 (pre and post) for evening exercise. The results found that leukocytes (WBC, NE and LY), erythrocytes (RBC, HGB, HCT, MCH and MCHC) and thrombocyte (PLT, MPV and PCT) show resulting differences ($p<0.05$) between the morning and evening exercises. Additionally, no significant differences were found in the other parameters in blood. In conclusion; Hematologic parameters display different behaviors exhibit acute exercise at different times of day. Leukocytes, erythrocytes and thrombocyte levels display different behaviors as exercises at morning and evening.

Keywords: exercise, thrombocyte, erythrocytes, leukocytes, hematology

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INTRODUCTION

Exercise is an important function of living systems. It affects many systems in our body. Human body adapts to exercise by breathing and by cardiovascular systems; such as, cardiac output is 20-25 liters during high intensity exercise [1] and also exercise may affect blood parameters. Physical and physiological response also plays an important role, in hematology [2]. When hematology is analyzed, the effect of acute exercise on hematological levels is seen different. It is stated that these differences depend on the severity, duration, exercise at different times of day and frequency of exercise as well as physical and physiological conditions of subjects [3].

Hematologic parameters, plasma, leukocytes and platelets, are very responsive to exercises which are done different time of day and different exercise [4]. Some changes in erythrocyte's metabolism and in affinity of hemoglobin to oxygen take place in organism of sportsmen-volleyball with high and low qualification under training loading [5]. Research has been found contradictory concerning the effects of training on red blood cells. The specific type and duration of exercise is of major importance in the adaptations of the blood cell system [6]. Training at various altitudes above the sea level also seems to increase hemoglobin more than training at sea level. When the number of red blood cells increases, their hemoglobin content causes the blood to become thicker and more resistant to flow through the body.

It is very common for national and international level of athletes to exercise several times a day during their training regimes (i.e. perform multiple daily session). Most people do exercise at different times of day. However, the impact of the different times of daily exercise and multiple daily exercise sessions upon blood has not been researched

thoroughly. Additionally, the effect of multiple daily exercise sessions upon night-time blood level has not been evaluated. We therefore designed the present study with the aims of determining to compare the hematologic parameters between the morning and evening exercise in high school students.

MATERIALS AND METHODS

Subjects

12 healthy, untrained male student subjects aged 20 years volunteered to participate in the study. All subjects were non-smokers, used no drugs affecting the cardiovascular system and had no contraindications to exercise. All of them submitted their written consents to participate after having been informed about the study protocol and possible risks involved. The study was approved by the local committee of ethics.

Physiological Parameters

Body weight, body height, body fat percentage, vertical jump and body-mass index (BMI) were determined approximately a week prior to the first admission. The BMI was calculated with the following formula: body weight (kg) /body height (m^2) [7]. The 12-minute run/walk test was conducted and aerobic exercise capacity estimated using Balke's equation [2]. Average power was estimated using the Lewis formula.

Exercise

Before the morning and evening exercise, the resting heart rate was taken with polar 610i and predicted maximum heart rates estimated by using the formula 220 – Age [8]. The subjects did the same (submaximal, %85 intensity) exercise at the same heart rate. The volume (including warm up and cool down) of morning and evening exercise is about 70 minutes and intensity of exercises is about 85%. After each drill, participants were rested passively between exercises. Passively means that they don't do any physical activity between the exercises. When the heart rate of participants fell down to between 115-125 beats per minute, participants continued the interval exercise again. All drills were performed with the same intensity and to the same heart rate by all participants. They used a heart rate monitor during exercise and recovery. The same procedure was used for evening exercise after a week.

Blood Parameters

Blood sample (for morning exercise), was taken at 08:00 and 09:00 (pre- and post- exercise). Blood sample (for evening exercise) was taken at 20:00 and 21:00 (pre- and post- exercise). Four milliliters of blood were collected from each participant in gel tubes. Hematological levels including Red Blood Cells (RBC), Hemoglobin (HGB), Hematocrit (HCT), Mean Red Cell Volume (MCV), Mean Cell Hemoglobin (MCH), Mean Cell Hemoglobin Concentration (MCHC), Red Cell Distribution Width (RDW), White Blood Cells (WBC), Lymphocyte (LYM), Neutrophil (NE), Monocyte (Mono), Eosinophil (Eos), Basophil (BASO), Platelets (PLT), Platekri (PCT), Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) were analyzed by means of an Archem H3000 Hematology Analyzer.

Statistical Analysis

All data were presented as mean ± standard deviation. Pre- and post-exercise values for the dependent variables were analyzed to determine if the distributions were normal using Kolmogorov-Smirnov (K-S) Normality test. Comparison, between pre- and post-exercise, was performed through the Paired-Samples T test procedure in order to examine the differences between tests. It was also used for comparing the differences for pre-test ME and EE and post-tests ME and EE. Significance level was set at $\alpha = 0.05$ and 0.01. The statistical package program was used to evaluate the results of the study [9].

RESULTS

The subjects studied had a mean age of 20.0 ± 0.0yr, body weight of 69.8 ± 2.3kg, and body height of 174 ± 1.6cm. The subjects had a anaerobic power, 147.32 ± 12.10kg-m/s, VO_2 max of 47.47 ± 1.97mL/Kg·min, vertical jump· 61.10 ± 6.45cm, body mass index (BMI) 23.13 ± 1.62, and a percent body fat of 10.63 ± 1.65%.

In leukocytes, there was significant increase on WBC count in morning pre- and post-exercise at the significant level of $p<0.01$ and also that of evening pre-and post-exercise at the significant level of $p<0.05$. The mean level of NE % and NE $10^{\wedge}3/\mu L$ increased at morning pre-and post-exercise at the significant level of $p<0.05$. But NE percentage decreased at evening pre-and post-exercise at the significant level of $p<0.05$. Meanwhile, the mean values of pre-test

of LYM % and LYM 10^3/µL was higher than that of the post-test at evening exercise (Table 1).

Table 1. Mean values (±SD) of leukocytes and exercise-induced changes (Δ) at Morning Exercise (ME) and Evening Exercise (EE)

Parameters	Morning Exercise 08:00–09:00h		Evening Exercise 20:00–21:00h		ME–EE 08:00–20:00h	ME–EE 09:00–21:00h
	Pre-exercise	Δ	Pre-exercise	Δ	Pre-exercise	Post-exercise
WBC (10^3/µL)	7.16±1.47	1.78±1.86*	8.16±1.17	2.42±1.71*	-1.0±1.0	-1.64±1.93
NE (%)	46.94±5.70	2.44±3.72*	55.70±10.46	-3.83±3.79*	-8.76±8.16* º	-2.49±9.76* ^
LYM (%)	42.92±6.20	-1.83±4.43	33.13±7.90	5.04±3.34*	9.79±5.72* º	2.92±6.79* ^
MONO (%)	6.12±0.84	-0.56±2.94	7.11±2.14	-0.73±1.45	-0.99±2.02	-0.82±3.00
EOS (%)	3.39±1.81	0.02±0.92	3.38±3.32	-0.39±0.72	0.01±2.05	0.42±0.91
BASO (%)	0.63±0.46	-0.07±0.57	0.68±0.51	-0.08±0.36	-0.05±0.27	-0.04±0.38
NE (10^3/µL)	3.36±0.79	1.04±1.14*	4.50±0.98	0.82±0.61*	-1.14±0/97	-0.92±1.44
LYM (10^3/µL)	3.06±0.81	0.68±0.96	2.73±0.87	1.39±1.08*	0.33±0.37	-0.38±1.22
MONO (10^3/µL)	0.43±0.12	0.01±0.24	0.58±0.18	0.10±0.19	-0.15±0.16	-0.24±0.31
EOS (10^3/µL)	0.25±0.16	0.60±0.08	0.28±0.24	0.06±0.14	-0.03±0.13	-0.03±0.18
BASO (10^3/µL)	0.03±0.05	0.03±0.07	0.04±0.07	0.04±0.07	-0.01±0.06	-0.02±0.04

*** p<0.01, * p<0.05, º ME and EE pre-exercise, ^ ME and EE post-exercise.*

In erythrocytes, the mean level of RBC at evening exercise was higher than the mean level of morning exercise. At the same time, there were significant increase at the mean level of HGB and HCT of morning pre-and post-exercise and also that of evening pre-and post-exercise at the significant level of p<0.05. The mean level of MCH and MCHC at evening exercise increased more than the mean level of morning exercise (Table 2.)

Table 2. Mean values (±SD) of erythrocytes, thrombocyte and exercise-induced changes (Δ) at Morning Exercise and Evening Exercise.

Parameters	Morning Exercise 08:00 – 09:00h		Evening Exercise 20:00 – 21:00h		ME – EE 08:00–20:00l	ME – EE 09:00–21:00h
	Pre-exercise	Δ	Pre-exercise	Δ	Pre-exercise	Post-exercise
RBC (10^6/µL)	5.05±0.37	0.17±0.44	4.80±0.23	0.15±0.10*	0.25±0.38	0.27±0.29
HGB (g/dL)	15.06±0.41	0.44±0.33*	14.57±0.39	0.66±0.30*	0.49±0.47	0.27±0.38
HCT (%)	43.68±1.38	1.23±0.94*	41.68±1.24	1.20±0.89*	2.00±1.56	2.03±1.12
MCV (fL)	87.92±2.62	-0.38±1.08	86.96±2.51	-0.25±0.84	0.96±1.16	0.83±0.93
MCH (pg)	30.30±1.13	-0.06±0.53	30.42±1.03	0.41±0.21*	-0.12±0.55* º	-0.59±0.24* ^
MCHC (g/dL)	34.44±0.64	0.07±0.55	34.92±0.47	0.59±0.24*	-0.48±0.59* º	-1.0±029* ^
RDW (%)	12.69±0.81	0.05±0.22	12.52±0.80	-0.13±0.20	0.17±0.40	0.35±0.29
PLT (10^3/µL)	227.20±39.55	38.02±24.96*	240.67±42.94	34.66±27.96*	-13.47±35.83	-10.11±41.65
MPV (fL)	8.96±0.74	0.40±0.41*	9.52±0.97	0.21±0.36*	-0.56±0.54	-0.37±0.59
PCT (%)	0.21±0.03	0.05±0.05*	0.22±0.04	0.03±0.05	-0.01±0.06	0.01±0.06
PDW (%)	15.91±0.42	0.01±0.19	16.32±0.48	0.17±0.34	-0.41±0.43	-0.57±0.36

** p<0.05, º ME and EE pre-exercise, ^ ME and EE post-exercise*

In thrombocyte, there were significant increase at morning pre-and post-exercise and also evening pre-and post-exercise on PLT and on MPV at the significant level of p<0.05. Mean level of *PLT* at morning pre-exercise increased more than morning post-exercise.

DISCUSSION

As a result of the research, it was found that there were a significance increase in the value of leukocytes; WBC and NE, and was a significance decrease LYM, between the morning and evening exercise. When a comparison was made between these changes and the ones in other studies carried out on hematological levels, both similarities and differences were observed.

The results are similar to the findings of Vogelaere et al. [10] who determined the effects of cold stress on routine hematologic parameters when subjects were submitted on long-lasting exercise. They found that WBC count was significantly increased during exercise in both 20^{0}C and 0^{0}C environmental temperatures. Meanwhile, Vogelaere et al. [10] searched the effect of negative thermal stress on hematological variables at rest, and during submaximal and maximal exercise were observed for young males who volunteered in two experimental sessions, performed in cold (0^{0}C) and in normal room temperature (20^{0}C). They found the same result that values for WBC also slightly increased during cold stress exposure. However he explained that this increase can partly be related to hemoconcentration but also to the cold induced hyperventilation activating the lung circulation. At the same time,

Gimenez et al. [11] researched the influence of work intensity and duration on the WBC and LYM count response to exercise was studied. They found that WBC and LYM increased at 150W, cyclo-ergospirometric protocols. However, during a 45min Square-Wave Endurance Exercise Test: WBC and LYM increased at the 158th min, in the same research. Another similar research study, Temiz et al. [12] searched that RBC mechanical alterations and oxidative damage were investigated after an acute exhausting exercise in rats, together with the leukocyte activation. They found that the leukocyte phagocytic activity increased significantly after the exhausting exercise and prolonged till 24 hours. RBC membrane lipid peroxidation was gradually increased till 24 hours. Gonzalo-Calvo et al. [13] was to investigate the changes in a large panel of emergent geriatric biomarkers in long-term trained elderly men to analyze the effects of long-term exercise on an aged population. They showed that long-term training was associated with lower levels of white blood cell counts and neutrophil counts.

We found significant differences in erythrocytes; RBC, HGB, HCT, MCH and MCHC, and in thrombocyte; PLT, MPV, PCT between the morning and evening exercise. However, there were no significant differences in the value of the remaining blood parameters. Similar results have been found in other studies. For example, Vogelaere et al. [14] observed a slight but not statistically significant increase of RBC, HGB and HCT and a plasma concentration during cold exposure. And they found that platelets count significantly increased during exercise in both 20^{0}C and 0^{0}C environmental temperatures. Still another study of Vogelaere et al. [10] found that at rest, hematological variables such as RBC and derivate HGB and HCT significantly increased during cold stress exposure, while plasma volume decreased. Remaining values for platelets also slightly increased during cold stress exposure. However this increase can partly be related to hemoconcentration but also to the cold induced hyperventilation activating the lung circulation. Maximal exhaustive exercise induced, in both experimental temperatures, significant increments of RBC, HGB and HCT while plasma volume decreased. Green et al. [15] researched to investigate the role of high-intensity intermittent exercise on adaptations in blood volume and selected hematological measures. Total blood volume based on plasma volume and HCT values increased by 4.5%, whereas red cell volume decreased by 6.4%. But in contrast to this study Green et al. [15] reported that measurements of hematological indices indicated significant reductions in whole-blood HCT, HGB concentration, HGB content, and RBC count. Their findings suggest that exercise intensity is a major factor in promoting exercise-induced hypervolemia and that rapid elevations in plasma volume can be induced early in training. Gimenez et al. [11] researched that the influence of work intensity and duration on PLT count response to exercise was studied. They reported that the increase was very small for HCT, [HGB], and RBC, in contrast with large changes for plasma, total plasma volume, [H+] and lactate at VO^2max cyclo-ergospirometric protocols. Temiz et al. [12] report that the leukocyte phagocytic activity increased significantly after the exhausting exercise and prolonged till 24 hours. RBC membrane lipid peroxidation gradually increased till 24 hours and there was a significant correlation between leukocyte phagocytic activity and RBC lipid peroxidation. There was a slight but significant decrease in MCV and increase in MCHC suggesting a cellular dehydration after 24 hours. Their results imply that activated leukocytes might play role in the RBC damage observed after exhausting exercise encouraging oxidative stress [12].

Different from our research, some studies stated that neither exercise nor cold inducement significantly modified the hematological indices (MCH, MCV and MCHC). Spiropoulos and Trakada [16] examined on marathon runners, no significant differences were found in hematological parameters before and after the marathon competitions in their study. Kara et al. [17] stated that there was no statistically significant difference in HGB, HCT, RBC, WBC and PLT values in elite athletes in two different branches. Schumacher et al. [6] showed that alterations of the red blood cell system and iron metabolism may influence physical performance with no difference was found between athletes and control group in HGB and HCT. They stated that reduced HGB, HCT and RBC levels were observed in endurance compared with strength and mixed-trained. Physical training itself has no significant effect on selected hematological variables in athletes compared with untrained control group. Cakmakçı [18] studied on taekwondoers that there was not a significant difference in WBC, RBC, PLT and HCT parameters in blood samples taken before and after the camp. Reitjens al. [5] compared the blood samples of athletes before and after the season in their study on 11 Olympic athletes and determined that there was no significant change in MCHC levels.

CONCLUSION

Hematologic parameters (leukocytes, erythrocytes and thrombocyte) are affected by exercise done in morning and in evening exercise. When we compare the difference of hematological levels between morning pre-exercise and evening pre-exercise, there was an increase in terms of leukocytes, NE % and LYM % and in erythrocytes, MCH and MCHC. When we compare the difference of hematological levels between morning post-exercise and evening

post-exercise, there was an increase in terms of leukocytes, NE % and LYM % and in erythrocytes, MCH and MCHC. There were differences between morning and evening exercise in terms of increase or decrease in the hematological level of subjects. Some of them were statistically insignificant and some were significant. These changes were within regular limits. Hematologic parameters display different behaviors exhibit acute exercise at different times of day.

REFERENCES

[1] M. L. Foss, S. J. Keteyian, Fox's Physiological Basis for Exercise and Sports. Sixth Edition, WCB/McGraw-Hill Book Company, USA. **1998**.
[2] P.O. Astrand, K. Rodalf, *Textbook of Work Physiology Physiological Bases of Exercise*, McGraw-Hill Book Company, New York, USA. **1986** pp 713-716.
[3] H. Koc, A. Tekin, A. Ozturk, R. Saraymen, K. Gokdemir, M. Elioz, M. *Afr. J. Microbiol. Res.*, **2012**, 6(9): pp. 2027-2032.
[4] W. L. Kenney, J. H. Wilmore, D. L. Costill, Physiology of Sport and Exercise, Human Kinetics, USA. **2012**.
[5] G. J. Rietjens, H. Kuipers, F. Hartgens, H. A. Keizer, **2002**, *Int. J. Sport Med.*, 23: 391-396.
[6] Y. O. Schumacher, A. Schmid, D. Grathwohl, D. Bultermann, A. Berg, **2002**, *Med. Sci. Sports Exerc.*, 34(5): 869-875.
[7] R. Eston, R. Reilly, *Kinanthropometry and Exercise Physiology Laboratory Manual*, *Test*, *Procedures and Data*. Volume 1: Anthropometry. Third edition published, 2 Park Square, Milton Park, Abingdon, Oxon, **2009,** pp 18, 29, 30.
[8] T. O. Bompa, G. G. Haff, *Periodization: Theory and Methodology of Training*. Human Kinetics. 5th Edition. **2009**
[9] J.H. Zar, *Biostatistical analysis*. Fourth edition. Prentice Hall. **1999**
[10] P. Vogelaere, M. Brasseur, A. Quirion, R. Leclercq, L. Laurencelle, S. Bekaert, **1990**, *Int. J. Biometeorol.*, 34(1): 1-14.
[11] M. Gimenez, T. Mohan-Kumar, J.C. Humbert, N. De Talance, J. Buisine, **1986**, *Eur. J. Appl. Physiol. Occup. Physiol.* 55(5):465-70.
[12] A. Temiz, O.K. Başkurt, C. Pekçetin, F. Kandemir, A. Güre, **2000**, *Clin. Hemorheol. Microcirc.*, 22(4): 253-259.
[13] D. Gonzalo-Calvo, B. Fernández-garcía, B. Luxán-Delgado, S. Rodríguez-González, M. García-macia, F.M. Suárez, J.J. Solano, M.J. Rodríguez-colunga, A. Coto-montes, **2012**, *Age*, 34(3) : 761-771.
[14] P. Vogelaere, M. Brasseur, R. Leclercq, A. Quirion, **1988**, *Can. J. Sport Sci.*, 13(1): 43-49.
[15] H. J. Green, J.A. Thomson, M.E. Ball, R.L. Hughson, M.E. Houston, M.T. Sharratt, **1984,** *J. Appl. Physiol.* 56(1):145-9.
[16] K. Spiropoulos, G. Trakada, *Lung.*, **2003**, 181(2): 89-95.
[17] E. Kara, M. Ozal, H.U. Yavuz, **2010**, *Selçuk Uni. J. Phys. Edu. Sport Sci.* 12(1): 36–41.
[18] E. Cakmakcı, **2009**, *Nigde Uni. J. Phys. Edu. Sport Sci.*, 3(1): 21-29.