SEASONAL ANALYSIS (SIX-MONTHS) OF BLOOD PARAMETERS OF KYRGYZ ELITE ATHLETICS ATHLETES BEFORE 2016 RIO OLYMPICS GAMES

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ABSTRACT

Objective: *In this study, exercise-induced changes in blood parameters of Kyrgyz elite athletes were evaluated during 6 months.*

Methods*: Eight male (n = 8) and three female (n = 3) athletes were included. Blood samples were taken at 3 months intervals before and after the exercise (shuttle run). Erythrocyte (RBC), total leukocyte (WBC), platelet (PLT), neutrophil (NOTR), lymphocyte (LNF) count, hemoglobin (HGB) and hematocrit (HCT) values, mean erythrocyte volume (MCV), mean erythrocyte hemoglobin concentration (MCHC) and also venous blood pH, PO2, PCO2, SAT O2, HCO3, BE, Na, K, Cl, serum glucose (Glu), total protein (TP), total cholesterol (TC), HDL cholesterol (HDL-C), triglyceride (Trig), blood urea nitrogen (BUN), creatinine (Creat), lactate dehydrogenase (LDH) and creatinine phosphokinase (CPK) levels were determined.*

Results*: The WBC, LNF, and NOTR values of the male athletes were found high ($p < 0.05$) after the exercise periods. In male athletes, HDL-C and BUN levels increased ($p < 0.05$), while Glu levels ($p < 0.05$) decreased due to exercise in each measurement. An increased pO2, O2SAT, K, and Anion Gap levels, however, decreased pH, pCO2, HCO3, and BE values were determined after the exercise.*

Conclusion*: Our data showed that exercise caused an acute increase in immune system cell counts (WBC, LNF and NOTR), also HDL-C and O2SAT values in male elite athletics athletes, but the six-month period did not cause any significant change in all of the blood parameters.*

Keywords: *biochemistry, blood gases, elite athletes, exercise and blood, Kyrgyzstan.*

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Introduction

Olympic Games is a great international multi-sport organization with social and cultural properties in which thousands of athletes from around the world participate in a variety of competitions to show their skills, and also represent their country. Besides, it has been performed in summer and winter seasons in different countries every four years since 1896[(1)].

One of the important Olympic Sports is an Athletics. Athletics meeting is the most important part of the Summer Olympics, which is a collection of sporting events, includes competitive running, jumping, throwing, and walking branches. The modern athleticism program contains track and field, road running, cross country running, and race walking competitions. It requires endurance, power, speed, agility, and sufficient physical coordination with cognitive and

emotional control[2]. In preparation periods for international elite sport organizations, athletes enter the extraordinary physical and mental training period for performing the high performance in competitions. Although there is a number of metabolic changes in the body due to extreme exercise (a strenuous activity) in the training period, athletes can normally compensate these disturbances such as mechanical hemolysis, intestinal bleeding, haematuria, sweating, iron deficiency, and poor absorption of iron[3].

Hematological analysis, is one of the crucial laboratory practises, consists of a numerical quantification of white blood cells (WBC), red blood cells (RBC), and platelets (PLT) with all their indices such as hemoglobin concentration (HGB), hematocrit (HCT), mean cell volume (MCV), mean cell hemoglobin (MCH), and mean platelet volume (MPV). It is generally used to determine the physiological or pathological status (exercise-induced dilution anaemia) of athletes, and also useful in the prediction of the onset of overtraining[4, 5]. As it is well known, short or long-term exercise induces metabolic changes in the liver, kidney, muscle, heart, and bone tissues. For instance, indicators of muscle metabolism consist of the creatien kinase (CK) and lactate dehydrogenase (LDH) are typically increased after exercise periods. CK and blood urea nitrogen (BUN) levels are also important to define the athlete's muscle damage and consequently to decide the potential return to exercise[6]. Besides, duration and period of exercise play a main role in glucose (Glu) uptake by skeletal muscle. In the blood, lipid profile is mainly consisted by low-density lipoprotein- cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), and triglycerides (TG). The exercise enhances the ability of skeletal muscles to utilise lipids. It can also cause a positive effect on the physical fitness of athletes with dyslipidaemia[7]. Physical exercise also affects the creatinine (Creat) volume excretion that is accepted as a first urinary biomarker of hydration status[8]. Besides, it was detected a correlation between the total protein (TP) levels and the grades of exercise[9]. The blood gas analysis also gives crucial informations about the metabolic and respiratory status of athletes during the exercise period[10]. Arterial sampling has potential to cause some undesirable complications such as pain, arterial injury, thrombosis with distal ischaemia, haemorrhage, median nerve damage, so venous sampling is often preferred in practise[11]. Exercise-induced changes can be obtained for blood pH, base deficit, HCO3, and pCO2 except pO2 in venous blood compared to the arterial[12].

Nevertheless, the monitoring of hematological, biochemical, and blood gas values of the athletes prior to competitions in certain periods provides some important performance indexes for both team physicians and trainers[13].

There are limited investigations on the variation of haematological, biochemical and also blood gas (especially) levels during the preparation and competitive seasons, however these studies are not including their changes in different parts of the season[14, 15].

For this purpose, we aimed to determine the fluctuations of hematological, biochemical, and blood gas values of the Kyrgyz elite athletes during the preparation period for the 2016 Rio Olympic Games.

Materials and methods

Participants

Detailed information was given to the athletes about the study design, and necessary forms were get signed. The study followed ethical guidelines consistent with the Declaration of Helsinki; the study protocol was approved by the ethics committee of Kyrgyzstan State Sports Academy Ethics Committee (No: 2015/175). Eight elite men (n = 8) and three women (n = 3) athletes participated in this study. The interval and duration (h) of daily regular exercise and dietary routine information were obtained through individual interviews and from coaches. All athletes were adults (mean age for male; 22, 29 ± 2, 87 and for female; 21, 67 ± 2, 08 years old), had an extreme daily exercise program (5.0 ± 0.3 h/day), and were on the elite category for 4.0 ± 1 years, participating in national and international tournaments. The athletes followed a similar dietary routine for the maintenance of adequate body composition for the sport modality during 6 months. During this study, the athletes did not use any vitamin or mineral supplements and were instructed to refrain from making any drastic changes in the diet.

Measures, Design, and Procedures

Bodyweight (BW) of the national elite athletes was defined with a portable scale (Angel, USA) to the nearest 0.02 kg. Besides, the height (HT) of the athletes was detected with a stadiometer (Holtain, UK) to the nearest 1 mm.

During each exercise period, a 20 m shuttle test was applied to the athletes to create fatigue. Before and immediately after the exercise periods (three times as periodically every three months), blood samples were collected from Kyrgyz National Athletes by

cephalic vein via needle (1.2mm × 38 mm) to normal and heparinized tubes, then transferred to the biochemical lab of Kyrgyz-Turkish Manas University Research Center under cold chain, and centrifuged at 3000g for 20 min in January, May, and July. Heparinized venous blood samples also transferred to the biochemical lab immediately after the collections. Serum and plasma samples were held in Eppendorf tubes until analysis time in a refrigerator (-20°C).

Plasma red blood cell (RBC), white blood cell (WBC), blood clot cell (PLT), granulocytes (NOTR) and agranulocytes (LNF) counts, hemoglobin (HGB) and hematocrit (HCT) values, mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC) were measured in the blood plasma samples by using automated biochemistry analyzer (BC-2300, Mindray, China).

Venous blood pH, PO2, PCO2, SAT O2, HCO3, BE, Na, K, Cl levels were determined from heparinized blood samples by using Electrolyte and Blood Gas Analyzer (IDEXX Vetstat, USA).

Serum glucose (Glu), total protein (TP), total cholesterol (TC), HDL cholesterol, triglyceride (Trig), blood urea nitrogen (BUN), creatinine (Creat), lactate dehydrogenesis (LDH) and creatinine phosphokinase (CPK) values were measured by using auto-analyzer (Mindray Perfect Plus 400, China).

Statistical analysis

Data were analyzed by using SPSS version 21.0 software (SPSS, Inc., Chicago, IL, USA) computer package program. Shapiro - wilk test was performed to determine the homogeneity of the data. Variance Analysis was also used for determining the differences between all three repeated measurements. Besides, Paired t-test was also used for binary measurements. A p - value < 0.05 was considered statistically significant. In addition, Wilcoxon signed-rank test also used for small size measurements.

Results

The bodyweight (BW) and the height of the national elite athletes were detected as 64,98 ± 2,72; 177,88 ± 6,31 for man and 56,5 ± 8,58; 171,66 ± 2,51 for women, respectively. WBC, LNF, and NOTR counts of the elite male athletes were found significantly higher ($p < 0.05$) after exercise periods in all three measurements (baseline, 3rd month and 6th month), shown in Table 4. It was not detected any statistically significant changes between the exercise periods (before and after) according to the other hematological parameters in both groups (male and female), shown in Table 1 - 4. In addition, there was no statistical difference between the before and after exercise periods in the three measurements ($p > 0.05$). Although HDL-C and urea concentrations increased significantly ($p < 0.05$) after exercise in male athletes, glucose concentration decreased significantly ($p < 0.05$) in all three measurements (baseline, 3rd month and 6th month) (Table 5).

Parameters (n=3)	I. analysis (Baseline)			II. analysis (3 months later)			III. analysis (6 months later)		
	PRE-EX Mean ± SD	POST-EX Mean ± SD	P	PRE-EX Mean ± SD	POST-EX Mean ± SD	P	PRE-EX Mean ± SD	POST-EX Mean ± SD	P
WBC *(10³/L)*	8,23±1,74	12,50±3,42	-	5,20±1,50	6,20±2,21	-	5,00±2,10	6,53±2,57	-
LNF *(10³/L)*	2,33±0,20	4,76±1,11	-	1,56±0,83	2,26±1,15	-	1,30±0,30	2,70±0,34	-
NOTR *(10³/L)*	0,40±0,26	0,60±0,01	-	0,13±0,05	0,23±0,05	-	0,23±0,05	0,60±0,30	-
HGB *(g/dl)*	154,66±3,78	158,00±9,64	-	143,66±4,93	203,00±23,81	-	201,66±16,50	196,00±6,08	-
RBC *(10⁶/L)*	5,45±0,26	5,46±0,40	-	4,81±0,07	6,88±0,64	-	7,48±1,38	7,37±0,99	-
HCT *(%)*	49,83±1,87	50,46±5,06	-	43,40±1,57	63,66±7,20	-	70,26±12,92	69,16±9,79	-
MCV *(fL)*	91,63±4,72	92,43±4,44	-	90,26±1,80	92,43±2,11	-	94,00±1,01	93,80±2,61	-
MCH *(pg)*	28,40±1,27	28,90±0,96	-	29,83±0,55	29,40±0,95	-	28,73±0,50	28,46±1,37	-
MCHC *(g/dl)*	310,00±4,58	313,33±12,20	-	330,33±2,51	318,33±1,52	-	306,00±5,56	303,33±6,56	-
PLT *(10³/L)*	307,33±38,85	366,00±49,75	-	197,00±71,12	131,33±55,37	-	133,66±52,17	148,00±19,46	-

Table 1: Average hematological parameters of the elite female athletes in different periods.
*(*P < 0,05 /(** P < 0,01)/(** * P < 0,001) was considered statistically significant in the same line. (PR-EX: Pre-Exercise)/ (PO-EX: Post- Exercise)*

Parameters (n=8)	I. analysis (Baseline)			II. analysis (3 months later)			III. analysis (6 months later)		
	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P
Glucose (mg/dl)	94,10±12,14	101,00±46,50	-	95,43±12,72	109,86±19,64	-	87,06±8,25	81,90±13,69	-
T. cholesterol (mg/dl)	189,10±11,10	154,36±53,56	-	183,20±14,01	182,03±28,44	-	198,26±24,39	197,43±4,90	-
HDL cholesterol (mg/dl)	65,00±15,00	75,00±8,18	-	54,33±20,64	65,00±15,87	-	63,33±7,63	77,00±3,60	-
LDL cholesterol (mg/dl)	132,00±21,87	115,70±41,40	-	139,10±22,08	123,00±27,56	-	141,80±23,64	128,80±22,65	-
Triglyserides (mg/dl)	137,33±5,13	136,66±10,59	-	134,66±7,50	164,00±17,08	-	158,00±22,51	191,00±17,08	-
T. Protein (g/dl)	6,53±0,11	5,40±4,70	-	6,53±0,15	7,53±0,20	-	6,43±0,25	7,50±0,30	-
Urea (mg/dl)	29,06±13,42	31,63±13,50	-	15,60±4,09	17,10±3,96	-	19,93±7,05	23,06±7,62	-
Creatinine (mg/dl)	0,88±0,13	0,96±0,19	-	0,95±0,10	1,03±0,12	-	0,92±0,20	1,07±0,26	-
CK (U/L)	122,00±36,37	190,33±33,56	-	95,00±15,39	111,33±21,93	-	99,33±4,72	133,33±43,98	-
LDH (U/L)	271,00±12,00	292,00±11,00	-	305,66±3,51	371,66±23,11	-	324,66±43,73	393,00±35,36	-

Table 2: Average biochemical parameters of the elite female athletes in different periods.
*(*P < 0,05 /(** P < 0,01)/(** * P < 0,001) was considered statistically significant in the same line. (PR-EX: Pre-Exercise)/(PO-EX: Post-Exercise)*

Parameters (n=3)	I. analysis (Baseline)			II. analysis (6 months later)		
	PRE-EX (Mean ± SD)	POST-EX (Mean ± SD)	P	PRE-EX (Mean ± SD)	POST-EX (Mean ± SD)	P
pH	7,36±0,03	7,24±0,04	-	7,34±0,07	7,29±0,05	-
P CO_2	48,33±4,93	44,66±10,59	-	48,33±4,93	44,66±10,58	-
P O_2	24,66±5,03	34,66±14,04	-	23,00±1,00	47,33±8,08	-
HCO_3	25,73±0,60	17,46±2,46	-	28,03±1,02	18,63±2,51	-
BE	1,13±0,77	-8,80±0,65	-	1,90±0,96	-7,66±6,67	-
O_2SAT	57,63±1,06	69,25±12,75	-	61,00±2,83	67,00±8,33	-
K	3,70±0,17	3,23±0,48	-	4,06±0,47	3,60±0,30	-
Na	140,00±0,01	138,66±3,21	-	139,66±0,57	140,00±0,01	-
Cl	107,00±1,00	106,66±1,15	-	107,66±0,57	108,66±0,57	-
Anion Gap	10,60±0,62	18,03±2,58	-	9,00±0,52	15,93±2,45	-

Table 3: Venous blood gas levels of the elite female athletes in different periods.
*(*P < 0,05 /(** P < 0,01)/(** * P < 0,001) was considered statistically significant in the same line. (PR-EX: Pre-Exercise)/ (PO-EX: Post- Exercise)*

It was also not defined significant changes between the exercise periods (before and after) according to the other biochemical parameters. Besides, no statistically significant difference was observed be-

tween the three measurements of the athletes before and after exercise periods ($p > 0.05$), shown in Table 5. In blood gas analysis, venous pH, pCO2, HCO3, and BE values were found significantly ($p < 0.05$) lower, however pO2, O2SAT, K, and Anion Gap values were detected significantly ($p < 0.05$) higher after all exercise periods in male athletes. Changes in Na and Cl- values were not found to be statistically significant ($p > 0.05$) in all measurement (Pre-Ex and Post-Ex) of the male athletes, shown in Table 6.

Parameters (n=8)	I. analysis (Baseline)			II. analysis (3 months later)			III. analysis (6 months later)		
	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P
WBC (10³/L)	7,44±1,85	11,57±2,66	***	6,01±1,89	9,36±2,64	*	6,55±2,25	9,09±3,27	*
LNF (109/L)	2,30±0,33	5,01±0,97	***	1,62±0,52	2,94±1,03	*	1,52±0,46	2,68±0,79	*
NOTR (109/L)	4,92±1,64	6,12±1,97	***	4,16±1,40	5,10±1,62	*	4,14±1,95	5,51±2,34	-
HGB (g/dl)	15,13±1,88	15,43±1,72	-	15,72±1,24	16,14±1,31	-	16,89±3,50	17,22±3,04	-
RBC (1012/L)	5,38±0,26	5,42±0,29	-	5,85±1,05	6,37±1,06	-	6,43±1,18	6,82±1,18	-
HCT (%)	46,21±2,44	49,70±2,72	-	45,66±9,26	48,27±10,59	-	46,30±12,10	52,55±10,67	-
MCV (fL)	83,97±4,05	85,66±3,75	-	82,11±2,52	84,53±7,84	-	78,69±2,80	87,11±2,58	-
MCH (pg)	28,40±1,10	28,54±1,21	-	28,69±1,30	28,42±1,21	-	28,34±0,55	28,34±0,84	-
MCHC (g/dl)	31,22±0,56	31,15±0,74	-	31,84±1,02	31,15±1,01	-	30,96±0,65	30,80±0,67	-
PLT (109/L)	267,00±44,36	298,20±43,49	-	212,90±68,58	239,20±91,89	-	164,40±67,71	179,90±76,14	-

Table 4: Average hematological parameters of the elite male athletes in different periods.
*(*P < 0,05 /(** P < 0,01)/(** * P < 0,001) was considered statistically significant in the same line. (PR-EX: Pre-Exercise)/(PO-EX: Post-Exercise)*

Parameters (n=8)	I. analysis (Baseline)			II. analysis (3 months later)			III. analysis (6 months later)		
	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P	PRE-EX (Mean±SD)	POST-EX (Mean±SD)	P
Glucose (mg/dl)	110,21±27,07	92,41±11,85	*	111,77±20,81	89,44±14,52	*	99,57±19,07	83,40±6,82	*
T. cholesterol (mg/dl)	193,93±11,42	189,57±36,74		195,70±20,76	191,81±20,93		195,72±19,71	197,84±18,85	
HDL cholesterol (mg/dl)	61,80±12,09	74,00±9,93	***	56,60±13,47	68,90±10,03	***	53,80±9,93	71,20±7,05	**
LDL cholesterol (mg/dl)	132,00±21,87	115,70±41,40		139,10±22,08	123,00±27,56		141,80±23,64	128,80±22,65	
Trygliserides (mg/dl)	128,70±10,08	131,40±17,61		145,70±22,78	154,10±27,99		143,89±30,98	166,56±32,91	
T. Protein (g/dl)	6,66±0,16	7,42±3,41		6,71±0,20	7,44±0,82		6,60±0,20	7,44±0,54	
Urea (mg/dl)	21,35±10,50	23,51±11,13	***	22,87±8,95	25,51±9,92	***	17,57±5,93	20,76±6,58	***
Creatinine (mg/dl)	0,89±0,11	0,92±0,13		0,99±0,20	1,05±0,23		0,88±0,11	0,99±0,13	
CK (U/L)	112,70±73,77	129,80±47,59		95,70±20,02	116,30±16,35		139,90±40,91	147,70±51,45	
LDH (U/L)	289,80±15,43	300,90±33,40		329,67±59,28	364,11±53,02		309,89±53,65	367,44±53,30	

Table 5: Average biochemical parameters of the elite male athletes in different periods.
*(*P < 0,05 /(** P < 0,01)/(** * P < 0,001) was considered statistically significant in the same line. (PR-EX: Pre-Exercise)/(PO-EX: Post- Exercise)*

Parameters (n=8)	I. analysis (Baseline)			II. analysis (6 months later)		
	PRE-EX (Mean ± SD)	POST-EX (Mean ± SD)	P	PRE-EX (Mean ± SD)	POST-EX (Mean ± SD)	P
pH	7,38±0,05	7,23±0,07	*	7,38±0,06	7,24±0,05	*
PCO_2	51,00±7,41	41,20±10,17	*	49,63±4,47	41,80±9,09	*
PO_2	46,88±3,87	58,13±18,15	*	46,00±4,87	60,63±14,10	*
HCO_3	26,81±1,93	18,80±3,67	*	26,68±1,97	19,20±2,96	*
BE	0,39±1,63	-8,26±3,42	*	1,20±1,48	-8,44±4,87	*
O_2SAT	57,63±1,06	69,25±12,75	*	61,00±2,83	67,00±8,33	*
K	3,38±0,33	3,76±0,15	*	3,51±0,34	3,98±0,41	*
Na	141,25±1,83	140,13±2,30	-	140,13±1,25	139,63±1,92	-
Cl	107,50±1,31	107,13±1,89	-	107,63±1,19	107,50±0,76	-
Anion Gap	11,03±2,62	17,25±2,95	*	9,55±1,07	16,53±2,55	*

Table 6: Venous blood gas levels of the elite male athletes in different periods.
*(*P < 0,05 /(** P < 0,01)/(** * P < 0,001) was considered statistically significant in the same line. (PR-EX: Pre-Exercise)/(PO-EX: Post- Exercise)*

Discussion

WBC, LNF, and NOTR values of the Kyrgyz elite athletes (male and female) were observed higher after exercise periods in all three measurements in the present study. Spiropoulos and Trakada[16] also detected similar results with ours in Greek athletes according to WBC, LNF, and NOTR values after a marathon race. This phenomenon has been supported by many other researchers[17, 18]. The increase WBC count by exercise can be mainly caused by the release of leucocytes from marginal pools depends on increased blood flow and catecholamine values[17, 19].

Although RBC, HTC, and HGB values were found higher in male athletes in all post-exercise periods, these values interestingly decreased in 3rd post-exercise measurements in female athletes. These values were also defined higher after a running train and exercise by other researchers in both male and female athletes[20, 21]. On the other hand, our results were inconsistent with some previous studies[16, 22]. These differences can be occurred due to poor nutritional intake of iron, intravascular hemolysis, blood and iron loss through menstruation, and loss of iron through sweating[16, 23]. However, there was no significant change between pre and post-exercise periods according to MCV, MCH, and MCHC levels in male athletes, it was detected a slight decrease in MCV, MCH and MCHC values in female athletes in 3rd post-exercise measurements in this study. Atan and Alacam[20] also found similar results in male athletes with our study according to MCH and MCHC values except for MCV levels after exercise periods. Interestingly, it was not detected any fluctuation in MCV, MCH, and MCHC values in an 8-week core exercise program exposed sedentary females[24]. It must be occurred due to blood and iron loss through menstruation in female athletes[16]. Although there was no significant changes in PLT values pre and post-exercise periods in male and female athletes, PLT levels of the male athletes were tended to increase after exercise, whereas in females, this value decreased to the lowest level in the second measurements in the present study. PLT values were defined higher in marathon athletes after the competition by Spiropoulos and Trakada[16]. Similarly, PLT values were detected higher in post-exercise periods in male athletes in a previous study[20]. It can be occurred due to the release of fresh platelets from the spleen or bone marrow due to the secretion of epinephrine[25, 26].

Although serum Glu values of the male athletes were defined lower in all post-exercise periods, these

parameters fluctuated in female athletes during the preparation period in this study. Glu values were detected higher in marathon athletes 4 hours after the competition by Kratz et al. which was inconsistent with our results[27]. In addition, Glu levels in triathlon athletes, however, were found significantly higher after the race when compared with the pre-race values by Long et al.[28]. Increased Glu values also detected immediately after a marathon competition by Spiropoulos and Trakada[16]. Differences can be explained by the exercise no reflect the rise in catecholamine levels which cause an increase in hepatic glucose production[1, 29]. Serum LDH and CPK levels increased in all post-exercise period measurements in both female and male athletes in the present study. Increased LDH and CPK values were also found after different resistance and aerobic exercise protocols in athletes by Callegari et al.[30]. Our results were similar to previous studies[31, 32]. It must be due to the activation of the glycolytic pathway in athletes. Another important enzyme for the evaluation of the hydroelectrolytic balance of the body is Creat levels increased in all post-exercise periods in the present study.

Our findings were similar with other studies according to serum Creat levels. In addition, serum Creat levels were observed remarkably higher in elite athletes than sedentary in previous studies[28, 33]. It can be thought to have excess muscle mass of the elite athletes. In addition, these may be occurred due to the intensity of training or not enough recovery[34].

TP and Urea levels of the athletes increased after the exercise periods in all measurements except 1st analysis of the female athletes which observed an interesting reduction. Souglis et al.[35] also determined increased urea levels following a Soccer, Basketball, Volleyball, and Handball matches. These parameters also determined higher after the short and long-distance running competitions by other researchers[16, 27, 36]. It can be explained to the extent of tissue damage-induced acute-phase reaction and/ or an increase in plasma fibrinogen values. Although TC and LDL values were determined lower after the exercise periods except the 3rd measurement of the male athletes, HDL values increased due to exercise in male and female athletes in the present study. LeMura et al.[37] and Vatani et al.[38] also found similar results with our study according to TC, HDL, and LDL values after resistance training. Interestingly, all three enzyme values were detected higher after the exercise periods by Banz et al.[39]. Similarly, TC levels were detected higher immediately after the marathon in a previous study[27].

Another important enzyme about the lipid metabolism is Trig values were detected higher after the exercise periods except 1st measurements of the female athletes in our study. Serum Trig values increased after the resistance training and aerobic exercise (moderate-intensity) in other studies[38, 40]. However, Kraus et al.[41] and Fett and Marchini[42] also found similar results according to Trig values after exercise and circuit training periods in athletes. Differences can be occurred due to increased volume of movement via increased numbers of sets and/or repetitions in different types of exercise and/or competition methods.

Venous blood pH levels decreased due to exercise in male and female athletes (in all measurements) in the present study. Azizi[43] also detected the same results in female athletes/non-athletes. In addition, decreased pH levels also determined by other researchers depend on the exercise[44, 45]. Although venous blood PCO2 values were detected lower after the exercise periods, PO2 values were found significantly higher in male and female athletes after the exercise periods when compared to the pre-exercise periods in the present study. Interestingly, both PCO2 and PO2 values were detected higher in female athletes in the post-exercise period by Azizi[43]. On the other hand, Lippi et al.(44) did not observe any significant change in PCO2 and PO2 values after the demanding physical exercise in athletes.

Differences in PCO2 and PO2 values must be observed due to an accumulation of the lactic acid and H+ ions in blood during the exercise[46]. Venous blood HCO3 and BE decreased, however, O2SAT and Anion gap values increased due to exercise in this study. Azizi[43] also detected similar results with ours according to HCO3 values in female athletes and non-athletes. There is limited information about the venous blood HCO3, BE, Anion gap, and O2SAT values after the exercise in elite athletes. Increased alveolar ventilation and also the consumption of bicarbonate by the body to compensate for the falling of pH may have led to occurring of these results.

Although K values decreased in female, increased in male athletes after the exercise in the present study, interestingly. On the other hand, there was no significant difference was detected in other parameters (Na and Cl) after the exercise periods in our study. Decreased Na and Cl, whereas unchanged K values were detected four hours after a marathon race by Kratz et al.[27] which was contradictory with our findings. Exercise-induced activation of the renin-angiotensin-aldosterone system can led to change of these parameters[47].

In conclusion, some hematological, biochemical and blood gas values of the elite athletes were defined, and influences of the exercise periods on elite athletes were evaluated before the Olympic Games. In addition, it was concluded that many blood parameters of the elite athletes affected acutely by exercise, but the six-month period did not cause significant changes.

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