Evaluation of Some Physiological Variables of Athletics Students in the Al-Esraa University College

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تقييم بعض المتغيرات الفسيولوجية في الطلبة الرياضيين في كلية الاسراء الجامعة

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Abstract

40 male students from the Department of Medical Laboratory Techniques, Al-Esraa University College, were divided into the control group which consists of 20 male athletes students which were picked due to their fitness and regular training, and the experimental group consists of 20 non-athletes students trained irregularly.

Four fitness tests (aerobic and anaerobic) were conducted to study five hematological parameters such as (leukocytes' count, PCV, hemoglobin concentration, blood pressure and heart pulses). Factors such as the type of exercise, an individual variation, the intensity of training, and the periods of training per day did have a great impact on the parameters. For example, athletes who trained regularly showed parameters' stability all the time.

The researchers observe changes in serum concentrations of some electrolytes of the two groups during different exercise intensities.

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Key words: Aerobic & Anaerobic Tests, Physiological Parameters, Electrolytes

المستخلص

قسم 40 طالباً من طلبة قسم تقنيات المختبرات الطبية، كلية الإسراء الجامعة، إلى مجموعتين: مجموعة سيطرة مكونة من 20 طالباً رياضياً من الذكور، تم اختيارهم بسبب اللياقة البدنية والتدريب المنتظم، بينما تكونت المجموعة التجريبية من 20 طالباً يمارسون الرياضة بشكل غير منتظم.

تم اجراء أربعة اختبارات لياقة بدنية (هوائية ولاهوائية) لدراسة خمسة معايير دموية مثل (عدد كريات الدم البيض، حجم كريات الدم المتراصة، تركيز الهيموجلوبين ، ضغط الدم وعدد نبضات القلب).

كان لعوامل مثل نوع التمرين ، والصفة الفردية، وكثافة التدريب، وفتراته اليومية تأثير كبير على النتائج، فعلى سبيل المثال، أظهر الرياضيون الذين تلقوا تدريبات بانتظام استقرار المعايير الدموية طوال الوقت.

لاحظ الباحثون تغيرات في تركيز بعض من الالكترولايت في مصل الدم خلال التمارين المختلفة.

الكلمات المفتاحية: الاختبارات الهوائية واللاهوائية ، المعايير الفسيولوجية، الإلكترولايت

Introduction

Physical activities and exercises are essential factors that promote human ability to fight psychological, social and economic stress. Students of universities are considered important elements that are hoped for in the educational and training processes, so directing students toward physical activities are important and essential in building their personalities, physical and psychological mentality (Musavian *et al*., 2015).

Students must be encouraged to engage in physical exercises outside their specialty. Physical fitness is generally consists of several categories such as:

flexibility, aerobic and anaerobic endurance, speed, muscle strength and peak anaerobic power (Musavian *et al*., 2015).

Exercises affected blood circulation and transferring components of oxygen which have an important role during and after activity. The proper training of such a student is necessary since exercises affected numerous physiological and biochemical reactions in a human body that may affect the performance of the student (Gharbi *et al*., 2015).

Aerobic activities are characterized with low-to-moderate intensity, therefore they can persist for hours, while anaerobic activities are very intense, therefore they persist for few seconds or minutes, so anaerobic fitness is a local characteristic of the muscle because of its independence on blood and oxygen supply to the muscle. This means that a person may have a high anaerobic performance in one muscle group and a lower anaerobic performance in another (Meckel *et al*., 2008; Gharbi *et al*., 2015).

Therefore, the researchers applied fitness tests (aerobic and anaerobic), that assessed leukocytes' count, packed cell volume (PCV), hemoglobin's concentration, blood's pressure and heart pulses.

The effect of running exercises is studied also on several electrolytes concentrations in the serum (Clark *et al*., 2003; Meckel *et al*., 2008).

Aims of the study

The evaluation of any physiological changes in some parameters (leukocytes' count, packed cell volume (PCV), hemoglobin's concentration, blood pressure and heart pulses), and also observing changes in serum concentrations of some electrolytes during different exercise-intensities among two (control and experimental groups) during exercise tests.

Materials and Methods

Samples of the Research

40 male students from the Department of Medical Laboratory Techniques, Al-Esraa University College, were chosen for the tests.

The control group consisted of 20 athletes male students which were picked due to their fitness, regular training and playing football games regularly (three times a week).The experimental group consisted of 20 non-athletes students trained irregularly (Table 1).

All students who participate in this research were advised strongly not to participate in strenuous exercises activities four days before the experiments.

Table (1) The homogeneity of participated students in terms of height, weight, age and training period.

Subject (40 male students)	
Height (cm)	165- 170
Weight (Kg)	60- 65
Age (years)	21- 22
Training period (years)	5-7

Blood Samples

Blood samples (3ml) were collected from all players 15 and 45 minutes before and after any exercise respectively.

The blood was preserved in anticoagulant tubes and kept at 4°C until tested. Blood pressure and heart pulses were measured pre- and post-exercises (within minutes) using automated sphygmomanometer (Automatic Wrist Digital Blood Pressure, Shenzhen Freestyle Co., Ltd., Germany).

It is very important to stop students from drinking fluids (or water) or eating after each exercise until blood samples were taken, since hydration brings the parameters back to normal (Hoffman *et al*., 2010).

Materials

Syringes, blood tubes, sensitive balance (German-DIAMOND), stopwatch, measuring tape, marker cones, cotton wool, sterile materials, microscope, hemacytometer chamber, micropipettes, and a centrifuge.

Tests Used in the Methods

There are more than 120 fitness tests that can be applied, but only four (three anaerobic and one aerobic tests) were conducted in this research since they were handy, rapid and easier to apply. These were:

1) **Phosphate Recovery Test**

It is an anaerobic test that assesses strength, agility and speed. This test consists of 60 meters straight line. Marker cones are placed two meters apart for the first and the last 20 meters. The middle 20 meters are free from the cones. The idea of the test is for the player to sprint the cones for seven seconds, then rest for 23 seconds and then sprint again for seven seconds and rest for 23 seconds, and so on continuously until the player finished the 120 meters straight line (forward and backward)(Meckel *et al*., 2008; Gharbi *et al*., 2015).

2) Lactate Threshold Tests

It is an anaerobic test that assesses muscular endurance and speed. The player climbs up and down a 40 centimeters high wooden bench during 5 minutes before resting (Goodwin *et al*., 2007).

3) Wingate Test

It is anaerobic test, also known as (Ergonometer Anaerobic Test) that assesses endurance.

Before starting this test, the player will perform a low-resistance warm-up for at least 5-minutes followed by rest for 1-minute, after which the test begins.

In this test, the player uses stationary cycle and will cycle at a maximum capacity for 30-seconds against a strong braking force. The braking force remains constant throughout the test, so the player cannot maintain the initial velocity for more than few seconds, before starting to slow down.

The choice of a 30-second protocol was based upon the fact that players are often reluctant to repeat the test (because it is so demanding) (Jaafar *et al*., 2014).

4) Harvard Step Test

It is aerobic test that assesses the endurance of the respiratory system. It can be considered as a cardiac stress test.

The player warms for 10 minutes, before steps up and down onto a standard gym bench once every two seconds for five minutes (150 steps). The rate of 30 steps per minute must be held up for five minutes or until exhaustion.

The player rests for 5 minutes and during that, heart pulses and blood pressure were recorded three times in a row (with one minute separate each recording)(Ryhming, 2000; Zagatto *et al*., 2011).

Evaluating Fitness Parameters

Five fitness parameters were chosen (Table. 2)

Table (2) Fitness parameters and their normal values

Fitness Parameters	**Normal value**
Leukocytes' count	4,500-10,000 per microliter (mcL)
PCV (Packed cell volume)	45-48%
Hb concentration	13.5-17.5g.dL^{-1}
Blood pressure	120-80mmHg
Heart pulses (heart rate)	75-90. min^{-1}

Evaluating Serum Electrolytes

The concentrations of nine electrolytes (Na^{+1}, Cl^{-1}, HCO_3^{-1}, Ca^{+2}, Cu^{+2}, Mg^{+2}, $Fe^{+2, +3}$, K^{+1}, and Zn^{+2}) in blood serum were evaluated by collecting blood samples (3ml) pre- and post tests and analyze them using electrolyte analyzer (EasyLyte Incop., USA)(Jung *et al*., 2005; Cinar *et al*., 2009).

RESULTS

The results of the three chosen blood parameters (leukocytes' count, PCV and hemoglobin concentration) as fitness indicators are shown in (Table 3).

Table (3) Effects of anaerobic and aerobic exercises on leukocytes count, PCV and hemoglobin concentration

	Anaerobic tests groups						**Aerobic test groups**	
	Phosphate R. test		**Lactate threshold test**		**Wingate test**		**Harvard Step test**	
Parameters	Control	Exper.	Control	Exper.	Control	Exper.	Control	Exper.
Leukocytes. mcl^{-1}	N.	++	N.	+++	N.	+++	N.	++
PCV%	+	++	+	+++	+	+++	+	++
Hb conc. ($g.dL^{-1}$)	N.	++	N.	+++	N.	+++	N.	++

N. Normal

\+ Slight increase

++ Moderate increase

+++ High increase

The results of two additional parameters (blood pressure and heart pulses) that were considered good fitness indicators are shown in (Table 4).

Table (4) Effects of anaerobic and aerobic exercises on blood pressure and heart pulses

	Anaerobic tests groups						**Aerobic test**	
	Phosphate R. test		**Lactate threshold test**		**Wingate test**		**Harvard Step test**	
	Control	Exper.	Control	Exper.	Control	Exper.	Control	Exper.
Blood pressure	N.	++	N.	++	N.	+++	N.	++
Heart pulses	N.	++	N.	++	N.	+++	N.	++

N. Normal

\+ Slight increase

++ Moderate increase

+++ High increase

Evaluating Electrolytes Concentration

The results of all nine electrolytes that were studied (Na^{+1}, Cl^{-1}, HCO_3^{-1}, Ca^{+2}, Cu^{+2}, $Fe^{+2, +3}$, K^{+1}, Mg^{+2} and Zn^{+22}) are shown in (Table 5).

Table (5) Effects of anaerobic and aerobic exercises on the concentration of electrolytes

	Anaerobic tests groups						**Aerobic test groups**	
	Phosphate R. test		**Lactate threshold test**		**Wingate test**		**Harvard Step test**	
	Control	Exper.	Control	Exper.	Control	Exper.	Control	Exper.
Ca^{+2}	N.	+	N.	+	N.	+	N.	+
Cl^{-1}	N.	+++	N.	+++	N.	+++	N.	++
Cu^{+2}	N.	++	N.	++	N.	++	N.	+
$Fe^{+2, +3}$	N.	++	N.	+++	N.	+++	N.	+++
HCO_3^{-1}	N.	+	N.	++	N.	+	N.	+
K^{+1}	N.	+	N.	+++	N.	+	N.	+
Mg^{+2}	N.	+++	N.	++	N.	+++	N.	++
Na^{+1}	N.	+++	N.	+++	N.	+++	N.	++
Zn^{+2}	N.	++	N.	++	N.	++	N.	+

N. Normal

\+ Slight increase

++ Moderate increase

+++ High increase

Discussion

Hematological parameters such as (leukocytes count, PCV, hemoglobin concentration, blood pressure and heart pulses) were chosen since they were among those responsible for the transfer of oxygen for active tissues.

Leukocytes are the body's immune system cells that fight infections by producing antibodies. When a slight elevation in the temperature of the body during (and after) exercises, harmful microorganisms might be encouraged to grow, so leukocytes would elevated in number and produce antibodies (which accelerated their activity level) that would prevent any infection, as shown in Table 3.

In case of well trained athletes, leukocytes' count would remain stable or elevated slightly during exercises since the body was adapted to strenuous work, unlike untrained students which show a clear elevation in leukocytes' count as shown in Table 3. The above results are agreed upon by some researchers (Johannsen *et al*., 2012; SilvaNeves *et al*., 2015).

PCV determines the capability of erythrocytes to transfer oxygen from lungs to body tissues. Both PCV and the concentration of hemoglobin are elevated after a strenuous effort in the experimental group. Therefore, both can be used as fitness' parameters (Table 3). Our results agreed with most previous researchers on this subject (Calbet *et al*., 2006; Brun *et al*., 2010; Alam *et al*., 2014).

Factors such as a type of exercise, an individual variation, an intensity of training, and periods of training per day will have a great impact on the parameters. For example, athletes who trained regularly showed parameters' stability all the time (Brun *et al*., 2010; Mairbauri, 2013).

Results showed that in most students, leukocytes' count, PCV and hemoglobin returned to normal after 1h of rest which agreed upon with (Mairbauri, 2013; Alam *et al*., 2014).

The strength of the heart muscles that lower blood pressure can be achieved through continuous exercises (Turmel *et al*., 2012). For this reason, the well trained athletes (experimental group) showed stable heart pulses and stable blood pressure after each of the four tests contrary to the (Control group) as shown in Table 4. These observations were noticed by other researchers (Bemben & Lamont, 2005; Turmel *et al*., 2012).

It must be noted that the body during the application of a phosphate recovery test would be able to store creatinine in the muscles (within a short-term energy system), so energy could be supplied quickly (Bemben & Lamont, 2005).

On the other hand, the amount of lactate presents in the blood was assessed by (lactate threshold test). Lactic acid (and pyruvate formed with it), would convert (through several cycles such as Cori cycle and Cahill cycle) into glucose again (due to a continuous demand of energy) in this long term exercise. Eventually, the body would begin to convert more glycogen into glucose (Kaczkowski *et al*., 2000; Hoffman *et al*., 2010). Therefore, before the end of the exercise, lactic acid amounts increased rapidly and the player's breath increased rapidly in order to provide enough oxygen to oxidize lactic acid as shown in Tables 3 and 4.

In the end of the test, the player reached his endurance point where lactate would accumulate rapidly accompanied by a burning feeling as the concentration of acid ions raises. These ions would block the energy production, so the player was unable to increase his intensity anymore (Belli *et al*., 2007; Jones *et al*., 2010).

The anaerobic Wingate test measures firstly the anaerobic capacity of any player including the performance in muscles, and the test, secondly, could assess the anaerobic muscles endurance. We noted as others did that this test is so demanding that the player must be motivated before and during the test verbally (Üçok, *et al*., 2005; Goodwin *et al*., 2007; Coppin *et al*., 2012; Jaafar *et al*., 2014).

During Wingate test, lactate-pyruvate and creatinine increased rapidly, but the period of the test (30 seconds) was too short period for these compounds as well for the glycogen to be converted into glucose (as was done in the lactate threshold test). Therefore, this test is used for the study of the endurance of muscles in its anaerobic state only. Some researchers estimated that only 16% of ATP (or perhaps as much as 24%) is regenerate through aerobic mechanisms in this test (Bogdanis *et al*., 2007; Coppin *et al*., 2012). Therefore, this test can be used with patients suffered from neuromuscular or musculoskeletal deficiency, so information can be provided about the reliability of rehabilitation, as well as comparing between the rehabilitation of the left and the right up (Zupan *et al*., 2009; Baker *et al*., 2011).

Aerobic Harvard test assessed the person's fitness and the ability to recover after a strenuous exercise. Actually, the fittest person is the person that his pulses rate returned to normal as fast as possible, so Harvard test is a cardiovascular endurance test that shows the ability of a person to exercise continuously for long periods of time without exhausting (Lunn, *et al*., 2015; Fernando *et al*., 2015).

During the test, the blood pressure increased but not nearly as much as was shown in anaerobic tests. This is due, according to some researchers, (Franklin & McCullough, 2009; Cooney *et al*., 2013) to the dilating of the blood vessels going to the muscles during aerobic exercise, even when heart pulses are beating more vigorously, but other studies showed that in the long term, people who demonstrate a raise in a blood pressure might be more likely to develop a high blood pressure later on, while others have not been so clear cut about the whole issue (Franklin & McCullough, 2009; Kodama *et al*., 2009).

During exercises, there are many mechanisms that contribute to elevate oxygen supply inside tissues. The skeletal muscles demand oxygen during exercises and that lead to increase the flow of the blood, and through increasing the heart pulses (Coppin *et al*., 2012; Fernando *et al*., 2015).

Continuous training increased maximal cardiac pulses and that increased the amount of oxygen that would be carried in the blood. So, during exercises, the trained students showed a stable blood pressure and a stable pulses, with no increase (or little increase) in blood parameters included in this research (such as leukocytes' count, PCV and hemoglobin concentration), in contrast to untrained students (Zagatto *et al*., 2011; Turmel *et al*., 2012).

Evaluating Trace Elements Concentration

Even though the changes in serum electrolytes concentrations were not significant, but they can be important from clinical point of view (Shirreffs *et al*., 2004; Montain *et al*., 2007).

Electrolytes during strenuous exercises could be elevated in the blood, but were depleted inside the cells.

The level of elevated electrolytes could not measure correctly since certain amounts of electrolytes were lost by sweat and perspiration during the long-term exercises or this decrease might result from the elevation in the muscle sodium-potassium pumping action accompanied by rapid loss of intracellular potassium (Bohl *et al*., 2002; Shirreffs *et al*., 2004; Rayssiguier *et al*., 2011).

Electrolytes levels remained stable in the control group which was expected, since most trained students compensate for the loss of electrolytes by means of their diet (Ruchan, 2011).

All nine electrolytes studied (Na^{+1}, Cl^{-1}, HCO_3^{-1}, Ca^{+2}, Cu^{+2}, $Fe^{+2,\ +3}$, K^{+1}, Mg^{+2} and Zn^{+2}) were depleted during exercises of the (experimental group). Mostly, electrolytes were lost through sweat during exercises especially in the endurance tests. These results agreed with (Ruchan, 2011; Stendig-Lindberg *et al*., 2012; Maynar *et al*., 2018).

Electrolytes, in general, remained stable during exercises in the (control group) (Table 5).

Serum sodium and chloride ions control body fluids and help in Adenosinee triphosphate (ATP) generation, so they could elevate and remove quickly in all tests through perspiration (Montain, *et al*., 2007; Emenike *et al*., 2014).

Potassium and bicarbonate ions were mostly intracellular interacting with sodium and chloride ions, so they were elevated slightly inside erythrocytes but remain difficult to be measured, due to the great loss of them during perspiration and urination (Coury *et al*., 2004; Chinevere *et al*., 2008; Stendig-Lindberg *et al*., 2012; Maynar *et al*., 2018).

Magnesium elevated slowly in blood serum during anaerobic lactic threshold and Wingate tests during our work, but remained stable during other tests. This agreed with other works done in this field (Rayssiguier *et al*., 2011), but it was difficult to explain the behavior of magnesium without further investigation, even when the researchers could not ignore its role with erythrocytes.

If the loss of magnesium through sweat exceeded its concentration in the blood, this might cause cramps in the muscles (Bohl *et al*., 2002; Kodama *et al*., 2009; Rayssiguier *et al*., 2011).

Zinc and copper were cofactors in many enzyme reactions and played important roles in the synthesis of hemoglobin as well as with various functions of cellular respiration. Their concentrations were significantly higher in anaerobic tests comparing to aerobic test. They could not be easily depleted in experimental group (Emenike, *et al*., 2014; Clenin *et al*., 2015; Maynar, *et al*., 2018).

Iron is one of three electrolytes that can be depleted easily. The others are calcium and iodine (DeRuisseau *et al*., 2002; Kunstel, 2005; Clenin *et al*., 2015).

The stores of iron could be depleted easily from the body, especially in untrained players. Depletion of iron during exercises is due to the increase number of erythrocytes which increases the demand of iron. This leads to the reduction of oxygen uptake which reduces the performance of the players (Cinar *et al*., 2009; Granell, 2014; Clenin *et al*., 2015).

Iron will be depleted faster in endurance tests (DeRuisseau *et al*.,2002; Granell, 2014).

Muscle cells stored 1% of calcium, while the other 99% were stored in the bones. During physiologic intensity tests, the loss of calcium is minimal since it has no ergogenic potential (Table 5), and if necessary, the bones can provide the muscles with enough calcium (Kunstel, 2005; Williams, 2005).

Further Works

Many athletes preferred to remain in progressive dehydration, which contrasts the hypothesis that adequate fluid ingestion during exercises enhance athletic performance, prevent a fall in plasma volume, maintain serum sodium concentrations and prevent a progressive rise in heart pulses, so more researches are needed to evaluate this hypothesis.

The Wingate 30 seconds period test is a limitation since it is too short to determine critical power, so a test of 3 minutes will be more appropriate.

Most of this study was done in a laboratory, which can have a detrimental effect on the player, so tests outside lab conditions can have different results.

Electrolytes metabolism and the importance of rich balanced diet are not fully understood yet, and further studies will be useful.

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