The Effects of Single and ComplexTraining Exercises on Erythropoietin, some Physiological Variables, and Record of 800- Meter Runners

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The purpose of this study was to investigate Identifying the concentration level the Erythropoietin, red blood cell count, hemoglobin, and (pH) in the blood, as well as VO2max, Cooper 12-minute run test, and record of running 800 meters in the pre-program and post- program measurements after completing a single training program and a complex training program for the two groups, The research sample consisted of 12 athletes who run 800-meter races. The results showed significant differences in pH between the pre-program and post-program in favor of the pre- program of the two groups , No significant differences were found between the control group and the experimental group with respect to these variables in the post- program measurement ,There were significant differences between the control group and experimental group in VO2max, Cooper's test running distance, and 800-meter running time in , the post-program measurement in favor of the experimental group ,Use of these biological changes scientific yardsticks to identify the cardiorespiratory system efficiency for all athletes and linking these vital biological efficiency variables.

Keywords, blood cell count, hemoglobin, (VO2max), Cooper's test running.

Introduction

Athletic competitions consist of different races, something that allows using a variety of training methods in order to develop the athletes' physical, biological, and digital capacities through structured training programs (Abdel-Alim, 1997).

Additionally, when planning the training load to achieve certain objectives through each training module, several physical elements are integrated (e.g. conducting speed improvement exercises, then performing aerobic endurance exercises) so that each training module develops more than one physical element. This type of load planning is referred to as 'the complex approach' (Bastawissi, 1999: Abdel-Alim, 1997).

Planning the training load to achieve one goal for each training module in order to develop only one physical element (e.g. powerful speed, aerobic capacities, or anaerobic capacities) is referred to as 'the single approach' (Bastawissi, 1999 , Abdel-Alim, 1997) .

Thus, identifying certain physiological and biochemical variables during training season contributes to positive adaptation processes. Identifying the concentration level of the Erythropoietin hormone, red blood cell count, hemoglobin level, power of Hydrogen (pH) in the blood, as well as the maximum volume of oxygen (VO2max), and record of 800-meter running.

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After the completion of the single and complex training programs, are among the essential factors for developing a scientifically sound training program for 800-meter runners.

As these variables influence the biochemical reactions within the muscles and the blood. These variables can also have a clear impact on the functional competence of athletes because the body's ability to transport, distribute and consume oxygen in the cells and tissues depends on the blood volume, the concentration level of the Erythropoietin hormone, red blood cells, and hemoglobin level (Heshmat & Shalaby, 2003, Hassan & Khazaal, 2002, Szygula, et al., 2014).

Moreover, blood acidity (pH) is one of the most important elements that determines the normal balance of the body's internal environment whether it is acid or alkaline through the functioning of blood buffers within the body. This internal balance of the blood influences several biological functions including VO2max (Hassan & Khazaal, 2002).

The 800-meter running race is an anaerobic endurance and lactic anaerobic endurance activity that relies on the race. Thus, anaerobic and aerobic endurance for the 800-meter runners are among the most important physical skills to be developed (Al-Badrawy, 2007:; Bastawissi, 1999; Abdel-Alim, 1997) .

Consequently, the research problem can be summarized as follows: identifying the concentration level of Erythropoietin hormone, red blood cell count, hemoglobin, and pH levels in the blood, as well as VO2max, Cooper 12-minute run test, and the 800-meter record are the most important biological measures that should be examined during training season .

In order to develop the physical preparation and training processes in a scientifically sound manner and to improve and increase the physiological, health, and physical competence of athletes during the training season. This can be done through the implementation of single and complex training programs for 800-meter runners for 12 weeks.

In an attempt to utilize the findings of the current study in advancing and improving the physical, physiological capacities and record of 800-meter runners.

Additionally, these biological measures are important scientific indicators of the physical and biological competence increase and decline, thus they are an opportunity to improve the physical and records of 800-meter runners. The purpose of the study are:

- Identifying the concentration levels of the Erythropoietin hormone, red blood cell count, hemoglobin, and power of Hydrogen (pH) in the blood, as well as VO2max, Cooper 12-minute run test, 800-meter record in the pre- program and post- program measurements (after the completion of a 12-week single and complex training programs) for the experimental and control groups.
- Comparing and determining the differences between the experimental and control groups with respect to these variables, and between the pre- program and post- program measurement (after 12 weeks).
- Comparing and determining the differences between the experimental and control groups with respect to these variables in the post- program measurements (after 12 weeks).

It was hypothesized that would be signtifcant differences in the concentration levels of the Erythropoietin hormone, red blood cell count, hemoglobin, pH, as well as VO_2max, Cooper 12-minute run test, 800-meter running time between the following:

a) Pre- program and post- program measurement after 12 weeks in favor of the post- program measurement in the control group.
b) Pre- program and post- program measurement after 12 weeks in favor of the post- program measurement in the experimental group.
c) Post- program measurements after 12 weeks of the experimental and control groups in favor of the experimental group.

Method

Participants

The research sample consisted of twelve 800-meter runners selected by purposive sampling from the Armed Forces players. Participants were divided into two groups: a control group that was trained using the single-training approach exercises; and an experimental group that was trained using complex-training approach exercises. Each group consisted of six participants between 20 and 23 years old.

Procedures

- The training program was implemented over a three-month period (12 weeks) and consisted of 72 training session in total. Each week included 6 training session for both the experimental (complex training approach) and control (single training approach) groups (Abdel-Fattah, 2012; Al-Badrawy, 2007; Bastawissi, 1999; Abdel-Alim, 1997).
- The training program was implemented and measures taken during the 2014-15 training season of 800-meter runners.
- Pre- program measurements for both the experimental and control groups were taken on Monday, 22 December 2014, at 5:00p.m. These measurements included:

a) Drawing a blood sample by medical analysis specialist, in order to identify the concentration of the research variables in the blood. This took place before the performance of Cooper 12-minute run test, so that the results would not be affected by the Cooper test.
b) B-Performing the Cooper 12-minute run test in order to identify the VO2max indirectly (Radwan & Al-Masoud, 2013; Al-Hazaa, 2009).
c) C-Running 800-meters to identify record of the two groups was conducted on Tuesday, 23 December 2014, at 5:00 p.m.

- The two groups started the session of their training programs on Saturday, 3 January 2015.
- The training session of both groups were completed on Thursday 26 March 2015.
- The post- program measurements were conducted on Saturday, 28 March 2015 at 3:00p.m. For the two groups and included Cooper 12-minute run test, in order to identify the VO2max.
- Other post- program measurements were conducted on Sunday 29 March 2015 at 3:00 p.m. and included: running 800 meters to identify record of the two groups, drawing blood samples by a medical analysis specialist at 6:00 p.m. after measuring record for 800-meter run.

Results

Variables and Measurement in the Control Group Table 1

Table 1 Differences between the Pre- Program and Post- Program Measurements of Research Variables in the Control Group N=6

Variables	Measurement	Mean of ranks	Total of ranks +	Total of ranks -	Z value	Sig. 0.05
Erythropoietin	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
Red blood cell count	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
Hemoglobin	Pre- program	3.5	21	0	-2.214	significant
	post- program	9.5				
pH	Pre- program	9.5	0	21	-2.207	significant
	post- program	3.5				
VO_2max	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
Cooper test	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
800-meter running duration	Pre- program	9.5	0	21	-2.201	significant
	post- program	3.5				

Variables and measurement in the experimental Group Table 2

Table 2 Differences between the Pre- Program and Post- Program Measurements of Research Variables Experimental Group

Variables	Measurement	Mean of ranks	Total of ranks +	Total of ranks -	Z value	Sig. 0.05
Erythropoietin	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
Red blood cell count	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
Hemoglobin	Pre- program	3.5	21	0	-2.214	significant
	post- program	9.5				
pH	Pre- program	9.5	0	21	-2.201	significant
	post- program	3.5				
VO_2max	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
Cooper test	Pre- program	3.5	21	0	-2.201	significant
	post- program	9.5				
800-meter running duration	Pre- program	9.5	0	21	-2.201	significant
	post- program	3.5				

Differences between the control and experimental groups in the post program measurements Table 3

Table 3 Differences between the Control and the Experimental Groups' Post-Program Measurements of Research Variables N=6

Variables	Groups	Mean of ranks	Total of ranks +	Total of ranks -	Z value	Sig. 0.05
Erythropoietin	Control group	6	11.5	9.5	-0.210	insignificant
	Experimental Group	7				
Red blood cell count	Control group	6	11.5	9.5	-0.210	insignificant
	Experimental Group	7				
Hemoglobin	Control group	7	9	12	-0.333	insignificant
	Experimental Group	6				
pH	Control group	6.5	11	10	-0.105	insignificant
	Experimental Group	6.5				
VO_2max	Control group	3.5	21	0	-2.201	significant
	Experimental Group	9.5				
Cooper test	Control group	3.5	21	0	-2.201	significant
	Experimental Group	9.5				
800-meter running duration	Control group	9.5	0	21	-2.201	significant
	Experimental Group	3.5				

Discussion

The research findings will be discussed in the same order of the research hypotheses.

Discussion and explanation of the results of the first hypothesis:

The researchers explain these results in light of what Abdel-Fattah (2012), Al-Hazaa (2009), Gillespie (2012) note, that red blood cells transport and distribute oxygen from the lungs to other body tissues, therefore low levels of the Erythropoietin hormone, red blood cells, and hemoglobin lead to a decline in the blood capacity to carry oxygen as well as a decline in VO2max, thus a decline in the physical performance especially during aerobic endurance activities. The Erythropoietin hormone increases red blood cell count, thus increases the hemoglobin concentration level and increases oxygen transport therefore improves the performance of aerobic endurance activities. Regular athletic training leads to changes in the blood. These changes include the increase in blood volume, the increase in the concentration levels of red blood cells and hemoglobin. This is consistent with Gillespie's study (2012), which finds significant differences in the Erythropoietin hormone, hemoglobin, pulmonary ventilation, and VO2max between the pre-test measurement (one day before starting the exercises) and post- program (on the last day of the week) in favor of the post- program measurement. Similarly, Zhijun (2012) finds significant differences in the concentration level of the Erythropoietin hormone, and red blood cells between the pre- program and post-program measurements in favor of all the post-test measurements. Additionally,

altitude training effectively helped increase the concentration level of the Erythropoietin hormone and red blood cells for excellent rowing players, thus increasing the aerobic fitness, aerobic and anaerobic endurance. Moreover, Ramadan & Abul-Hamd (1994) studied 800-meter runners and found significant differences between the pre- and post-test measurements in red blood cell count, hemoglobin level, and VO2max of the control group, which finished the traditional training, and of the experimental group, which used breath control exercises, in favor of the post-test measurement.

On the other hand, Abdel-Fattah (2003) and Heshmat, et al. (2013) noted that high-intensity exercise reduces arterial blood pH from 7.4 to 7.2, which is acidic, and it can also reach 6.8, which is considered a point of physical fatigue. Thus, fatigue becomes apparent mainly in the increase of blood acidity. When blood and muscle acidity increases, this contributes in the reduction of the activity of enzymes and reaching a stage of muscular fatigue. Al-Safy, et al. (2011) reached similar findings. They found significant differences in the pH between the pre-test and immediate post-test measurements in favor of the pre-test measurement. They also found that the pH moved toward acidity in the control and experimental groups. They also found that lactic endurance exercises for 200-meter free swimmers contributed to the increase in lactic acid levels in the blood and a decline in the pH toward acidity. Moreover, they found significant differences in the hemoglobin levels in the pre-program and immediate post- program measurements of the experimental group in favor of the immediate post- program.

Additionally, Abdel-Fattah (2003) noted that VO2max improves with the performance of aerobic endurance exercises. Abdullah (2009) agreed with these findings, as his study found significant differences between the pre- and post-program measurements in favor of the post-test measurement in the control and experimental groups after the performance of traditional and proposed training programs for advanced football referees in a number of physical variables, namely Cooper 12-minute run test and VO2max. Likewise, Abdel-Alim (1997) found significant differences between the pre- program and post- program measurements in respiratory-circulatory endurance time, speed endurance for 400 meters, speed endurance for 600 meters, maximum speed time, and record for running 800 meters in favor of the post-test measurements in both the single-training approach and complex-training approach groups. Additionally, Motehar (2012) found significant differences between the pre-test and post-test measurements in favor of the post-test measurement in VO2max calculated through Cooper test, the improvement of 200, 400, and 600 meters running time, and the increase of the 12-minute run distance in Cooper test, after long-distance runners finished repetition-training program for 8 weeks. Omar & Abul-Hamd (1999) pointed that using Billat's training method (30/30 s) as a weekly training dose in addition to the regular training program in the experimental group, and using the regular training program in the control group, helped improve VO2max, and increased the distance of running 6 minutes in the experimental group. Therefore, the findings pointed out significant differences between the pre-test and post-test measurements of both the control and experimental

groups in favor of the post-test measurements in Cooper test distance, relative VO2max, 6-minute run distance.

Discussion and explanation of the results of the second hypothesis:

The researchers explain the results of the second hypothesis in light of the findings of Abdel-Fattah (2012; 2003), Al-Qutt (2002), Hassan & Khazaal (2007), and Al-Hazzaa (2009), that the VO2max is associated with an increase in the blood volume, an increase in the Erythropoietin level, red blood cell count, and an increase in hemoglobin level. The overall blood volume, red blood cell count, and hemoglobin level increase with increasing the intensity of training, especially aerobic endurance exercises. The hemoglobin concentration level is one of the most important and effective factors in transporting and consuming oxygen in body cells and tissues, since hemoglobin is the primary transporter of oxygen in the body. Sports training helps and leads to a remarkable increase in blood volume, red blood cell count, and hemoglobin level. This increase is positively reflected on the increase in oxygen transport and consumption in the muscles used during the performance of physical effort, thus an increase in the physical and health efficiency.

The findings of Szygula et al. (2014) were consistent with these findings. Szygula et al. (2014) aimed at identifying the effects of aerobic and anaerobic various-intensity exercises on the concentration of Erythropoietin hormone, red blood cell count, and hemoglobin concentration level in low temperature. Blood samples were drawn, and measures were taken (pre-test, post test after finishing 10, 20, and 30-minute intensive physical exercises in different low temperatures). Two groups were examined: a control group exercising in room temperature, and an experimental group exercising in very cold temperature. The study found significant differences in the concentration level of Erythropoietin hormone, red blood cell count, and hemoglobin between the pre-test and three post- program measurements (after 10, 20, and 30 minutes respectively of finishing aerobic and anaerobic exercises) in favor the three post- program measurements of both the experimental and control groups. Similarly, Ibis, et al. (2012) aimed at identifying the concentration levels of red blood cells and hemoglobin in the pre- and post-test measurements after skiers performed plyometric exercises for 12 weeks (a total of 60 training modules, and 5 training modules per week). The study found significant differences in the red blood cell count and hemoglobin concentration levels between the pre-test and immediate post-test measurements in favor of the latter.

On the other hand, Abdel-Fattah (1999) pointed out that maximum intensity and less-than-maximum intensity exercises that continue for short intervals produces energy anaerobically, thus lactic acid accumulates in the muscles, which leads to the acidity of the blood and the blood pH decreases to 7.35. Sayed (2014) also noted that aerobic and anaerobic physical performance increases the pH in the acidic direction, and blood buffers work on maintaining the pH in the normal range. Hemoglobin is one of these buffers that aim at maintaining the pH in normal range. Awadd & Awaad's (2011) findings are consistent with the aforementioned findings. Their study noted that high-intensity interval training for speed endurance contributed to the increase in blood pH in the acidic direction. Therefore, the results showed significant differences between the pre-test and post-test measurements in the level

of pH in the acidic direction after performing a training program using high-intensity interval training method for 400 meter runners in favor of the pre-test measurement. Similarly, Saikko's study (2015) aimed at identifying the pH level in the pre-test measurement before implementing a training program for speed, endurance, and muscle power, and the post- program measurement immediately after finishing this training program for 9 weeks. Blood samples were drawn for the pre-test measurement, after 3 weeks of medium-intensity physical training, after 3 weeks of high-intensity physical training, and after 3 weeks of recovery modules. The study found significant differences in the pH levels between the pre-test and post-test measurements in favor of the pre-test measurements. Additionally, blood acidity declined in the immediate post-test measurement, which indicated that the pH moved in the acidic direction during physical training. On the other hand, Hassan & Khazaal (2007) found that blood pH was an important factor/indicator of determining and maintaining the internal balance of the body, something which affects a number of vital functions of the body including VO2max. During high-intensity physical activities, the pH increases. This increase is accompanied by higher oxygen consumption. Thus, the pH level in athletes is one of the most important factors for determining the VO2max.

Additionally, Abdel-Alim's study (1997) found significant differences between the pre-test and post-test measurements with respect to respiratory-circulatory endurance, speed endurance of running 400 meters, speed endurance of running 600 meters, maximum speed, and record of running 800 meters, in single-training approach and complex-training approach groups. Motehar's study (2012) also found significant differences in VO2max calculated through Cooper's 12-minute run test, the improvement of 200, 400, and 600 meter running time, the increase of the distance run in Cooper's 12-minute run test between the pre-test measurement and post-test measurement taken after finishing repetition-training program composed of 48 training modules over 8 weeks in long-distance runners in favor of the latter. Moreover, Omar & Abul-Hamd (1999) found that the use of Billat's training method (30/30 s) as a weekly training dose alongside with the regular training program in the experimental group, and the use of the regular training program in the control group led to the improvement of VO2max, and the improvement of 6-minute run distance in the experimental group. Thus, the results revealed significant differences between the pre-test and post-test measurements in favor of the post-test measurement in Cooper's test, relative VO2max, and 6-minute run test in both the experimental and control groups.

Discussion and explanation of the results of the third hypothesis:

The researchers explain the results of this hypothesis in light of the findings of Szygula et al. (2014). Szygula et al.'s study (2014) aimed at identifying the effect of various-intensity aerobic and anaerobic exercises on the level of Erythropoietin, red blood cell count, and hemoglobin level in different low temperatures. Blood samples were drawn and measures were taken in the pre- program measurement and the post- program measurement after finishing intensive physical training for 10, 20 and 30 minutes respectively, in different cold temperatures. The research sample was divided into a control group composed of 15 students who exercised in room

temperature, and an experimental group composed of 15 students who exercised in very low temperatures. The study found no significant differences between the two groups in the concentration levels of Erythropoietin hormone, red blood cell count, and hemoglobin level in the three post-test measurements. Furthermore, a study by Allen et al. (2008) aimed at identifying the effect of varying strength training for 10 weeks on the red blood cell count and hemoglobin level, through the implementation of endurance training program and maximum power training, on the pre- and post-test measurement after 10 weeks. The research sample of Allen et al.'s study was divided into two groups: a control group that performed endurance training program, and an experimental group that performed maximum power training. They found no significant differences in red blood cell count and the hemoglobin level in the post-test measurements of the control and experimental groups after 10 weeks. Koushki et al., (2012) also aimed at identifying red blood cell count and hemoglobin level in the pre-test and immediate post-test measurements after performing an intensive training dose of wrestling exercises. Their research sample was divided into a control group composed of 7 wrestlers who performed the training dose in the morning, and an experimental group of 12 wrestlers who exercised in the afternoon. The study could not find any significant differences in red blood cell count and hemoglobin levels in the post-test measurements of the two groups. Azarbayjani, et al. (2013) also aimed at identifying the red blood cell count and hemoglobin level after performing six different anaerobic exercises. Blood samples were drawn in the pre-test and immediate post-test measurements. Azarbayjani and his colleagues found no significant differences in red blood cell count and hemoglobin levels between the pre-test and immediate post-test measurements in all six anaerobic exercises , Bracken & Brooks (2010) aimed at identifying red blood cell count, hemoglobin level, and pH level in the first application before starting a 7-week speed training program, and in a second application after completing the speed training program. Blood samples were drawn for a pre-test measurement and a post-test measurement immediately after exercising on the treadmill continuously for 3 minutes, in order to identify the concentration levels of the research variables. This took place for both the first and second applications. The study found no significant differences in red blood cell count, hemoglobin level and pH level between the post-test measurements of the first and second applications. Al-Safi, et al. (2011) found that lactic endurance training and traditional training led to significant differences in pH level between the pre-test and post-test measurements in favor of the pre-test measurement in a sample of 200 meter free swimmers. The pH level moved toward the acidic direction in the control and experimental groups. The study also found no significant differences in the hemoglobin concentration level between the control group and the experimental group in the immediate post-test measurement. Abdullah (2009) also noted significant differences between the pre-test and post-test measurements in favor of the latter, after completing a proposed training program and a traditional training program of advanced football referees in several physical variables, namely Cooper's 12-minute run test and VO2max in both the control and experimental groups. He also found significant differences between the control group and the experimental group with respect to Cooper's test and VO2max in the post-test measurement in favor of

the experimental group. Additionally, Omar & Abul-Hamd (1999) noted that using Billat's training method (30/30 s) as a weekly training dose in addition to the regular training program in the experimental group, and using the regular training program in the control group, helped improve VO2max and 6-minute run distance in the experimental group. Their study also found significant differences in the post-test measurements of the experimental and control groups in Cooper's test, relative VO2max, and 6-minute run distance in favor of the experimental group.

Conclusions

- The 12-week training program led to an increase in the concentration level of Erythropoietin, red blood cell count, hemoglobin level, an improvement in VO2max, Cooper's test distance, 800 meter running time for both the control group (single-training approach) and the experimental group (complex training approach). The results showed significant differences in the concentration of these variables between the pre- program and post- program measurements in favor of the latter for both groups. The results also showed significant differences in the pH in the acidic direction between the pre-program and post- program measurements in favor of the latter for both groups.
- The effect of the 12-week training program was equal in the post- program measurement of the control group (single-training approach) and the experimental group (complex-training approach) with respect to the concentration level of the Erythropoietin, red blood cell count, hemoglobin level, and pH level. Therefore, no significant differences were found between the control and the experimental groups with respect to these variables in the post- program measurement.
- The 12-week training program improved VO2max, Cooper's test distance, and 800 meter running time in the experimental group (complex-training approach). Therefore, significant differences were found between the control group's and the experimental group's post- program measurements (after 12 weeks) in VO2max, Cooper's 12-minute run test, 800-meter running time in favor of the experimental group.

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