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Physiological and Biochemical Indexes for the Development of Physical Condition of Higher Level Players During the Preparation Period

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ABSTRACT

The present study is a trial to predict the physical conditions of the players by testing the physiological and biochemical status. Accordingly, especial training program was applied on a sample of 12 players whom were then divided into two groups. The first group composed of 5 players and the second composed of 7 players. The application of the proposed training program led to obvious improvement in pulse rate at rest and pulse rate after effort by -38.36 and -8.18%, as well as reduced the rate of accumulation of lactic acid in blood at the rest and after the effort by -28.97 and -25.92%, respectively. That great increase in the pulse rate of heart leads to increase in the efficiency of the circulatory system during training by improving the ability of the heart to pump blood more efficient than it was. The effort in the training increases the efficiency of the circulatory system, which helps to get rid of lactic acid accumulated in the muscle, as results of application of the improved training program on the players. The present study concluded that, the changes in the level of the pulse rate after violent exercises are inevitable results, which accompanied with increasing of the breathing rate during training.

Key words: Physiological and biochemical index, heart pulse rate, physical condition, preparation period

INTRODUCTION

The technological revolution became the first dominant on all levels, fields and sectors, whether in industry, agriculture, medicine, engineering, etc. This revolution influenced on the science of athletic training and made it very diverse, so it is too difficult for researchers to follow up these variations. Since any training is aware of the technological development both in tools and devices that help in training (Moran and Glynn, 1997). Such devices are contributing in the development of the training process. In spite of the foregoing, some teams do not have the potential that allows them to use technology. The inability to use these devices inside the stadium makes it more difficult. Alternatively, the most important issue in this respect is the general appearance of the player, which expressing the functional status of the player and his vital changes that occurred due to the physical effort exerted during training (Mansour, 1996; Mark, 1996; Ronald and Shirreffs, 1996).

The first noticeable appearance on the player is the amount of sweat caused by the physical effort, which is the first indication to the arrival of the player to the stage of warm-up and that he

is ready for the burdens of training without hurt (Pauletto, 1994; Rowell, 1996), this could be inferred during the training through the heart rate (pulse) of the player whether at rest or after physical effort. Heart rate is one of the simplest procedures that can be used to evaluate the player during training and can also be used to estimate and regulate training load (Winter *et al*., 2007), accordingly, improving the heart rate (pulse) of the players from one season to another.

The maximum rate of heart pulse depends on several factors as, the amount of venous blood returning to the heart, the ventricular capacity and the capability of ventricular systolic, pressure of blood in aorta and pulmonary arteries (Hopper *et al*., 1997; Savas *et al*., 2007). When these factors improved, the rate of heart pulse increases to its maximum, thereby increasing the efficiency of the heart and pushes more blood. It's worth mentioning that the volume of blood pushed from heart increases as the heart pulse goes greater, thus increasing the amount of blood received by the tissues and muscles (Alonso *et al*., 2003).

Several studies confirmed that the more amount of blood run through the muscles the more getting rid of the lactic acid accumulation. The majority of lactic acid is generated mainly in the muscles more than its composition in the intestine, liver, skin and blood (Kirwan *et al*., 1988). Then, transported to the liver to be converted into glycogen, later, glycogen breaks down and converted into glucose (Mora, 2005). When more effort done, more amount of adrenaline hormone is secreted accompanied with increasing of breaking down of glycogen, which is converted into glucose, that increases the accumulation of lactic acid in blood (Longhurst *et al*., 1980; Wolfe *et al*., 1988).

Stanley and Wisneski (1996) investigated the impact of training on the production of lactic acid during the gradient physical exercises and the speed of getting rid of lactic acid, they found that increasing the effort led to increase of lactic acid production in the blood and therefore disposal of such lactic acid is required (Mora, 2006). The decline in the lactic acid content is linked, to large extent, to the amount of blood in the muscles, when more amount of blood is received by the muscle, the ability of the muscle to get rid of lactic acid increases. So, the rate of lactic acid in the blood is one of the most important biochemical indicators and responses for the development of the training process, which indicates whether the training takes place or not (Stanley and Wisneski, 1996; Bompa, 1999; Delavier, 2001).

Since the physiological and biochemical status are hidden indicators, they could be deduced through some of the physical characters associated with them, such as the respiratory system, circulatory system, speed endurance and the other associated physical abilities. Although, most of the training program aim at improving the physical and physiological status of the players, it is difficult to follow-up the players within the stadiums. Therefore, the present study is a trial to deduce the physical conditions through the physiological and biochemical status of the players.

MATERIALS AND METHODS

Sample: The sample of the current investigation was chosen from the first division club (Eastern Company) and the study was carried out on 2 and 3 July (2009). The sample consists of 13 players; one of them was eliminated because he did not participate in the implementation of the training program, so the actual number of sample was 12 players whom were then divided into two groups. Experimental first group composed of 5 players and the second composed of 7 players, taking in the account the harmony between the two groups, to fit with the nature of the team formation during the competitions.

Methodology: The experimental approach was used in the present study, where the experimental sample was divided into groups and the method of prior and posterior measurement was applied.

The tested independent variable: The tested independent variables are; periodic respiratory endurance, endurance of transition speed, muscles strength, muscle capacity, flexibility, pulse rate, blood pressure and the rate of lactic acid in the blood.

Research tools: The devices and equipment used in the present investigation are:

- The digital Restameter device; to measure the height and weight
- The stopwatch; to measure time
- Dynamometer device; to measure muscle strength
- Measuring tape; to measure the distance of jump, which acts as indicator for the performance of muscle
- Measuring stick; to measure the flexibility of shoulders, blood pressure measuring device (stethoscope)
- Medical balls; to measure the distance of push, which express the power of the arms muscles,
- Set and Reach device; to measure the flexibility of the spine (backbone) from the front while sitting
- Centrifuge; to separate blood components and finally
- Test tubes; to collect blood samples

Tests used during the study:

- Test of running 1500 m; to measure the level of endurance of speed
- Test of running 3600 m; to measure the level of respiratory system endurance
- Measuring the muscles strength of the fixed two legs using the Dynamometer
- Measuring the fixed strength of chest muscle using Dynamometer
- Sergeant test; to measure the distance of the vertical jump, which indicates the capacity of the muscle
- Throwing the medical ball while sitting; to measure the strength of the arms muscles
- Testing the flexibility of shoulders using measuring stick
- Testing the flexibility of the spine (backbone) from the front while sitting
- Measuring the blood pressure
- Measuring the rate of the pulse
- Measuring the amount of lactic acid in the blood at the laboratory

Preliminary study: Preliminary study was conducted on a sample of 12 players under 16 of age, from Eastern Company Club team and the study aimed to determine the difficulties that may face the investigation while measuring the variables of the research, as well as determining how far devices and tests are suitable for measuring processes, in terms of the integrity and validity, The preliminary study also, aimed to perceive about how the tests and measurements will be done.

Prior measurements: Before the application of the training program, prior measurements (biochemical, physiological and physical variables) were carried out on 2 and 3 July, 2009.

The application of the training program: The training program was designed to be applied during the preparation period for the players. The players received the training program for three months, with 4 units of training per week. The training program included 48 units of training; each

training unit contains 14-19 exercises. The number of exercises within the unit, the aim of the experimental unit, the number of groups and the rest periods are the main factors that determine the time of application for each exercise. Accordingly, the time of a unit ranged between 75-120 min (Roger, 2000).

The training program was implemented in three phases. The first phase targeted the development of the endurance of the respiratory system and muscle strength (Thomas *et al*., 1994). The second phase targeted to completion of development of the endurance of the respiratory system, muscle strength and flexibility. The third phase continued to achieve the goals of the second phase, so the development of the endurance of respiratory, muscle strength and flexibility lasted for three months, while the development of transition speed, muscle power and speed lasted for two months (Steven *et al*., 1997; Bompa, 1999).

Posterior measurement: After the application of the training program, posterior measurements (biochemical, physiological and physical health) were carried out on the players on 24 and 25 September, 2009.

Statistical analysis: The statistical package "SPSS" software was used. Wilcoxon test was used to find significant differences between the two kinds of measurements, before (prior) and after (posterior) the training program. All experiments were performed in triplicates and the statistical z-test at probability level of $p \leq 0.05$ was used to determine whether two population means are different.

RESULTS AND DISCUSSION

Regarding the variation in physiological and biochemical status of the tested players prior and posterior application of the training program, data (Table 1) show significant differences between the two kinds of measurements, before and after the training program in the physiological and biochemical status, where the calculated z values (which ranged from 2.06-4.301 at $p = 0.05$) is less than the tabulated value according to the test of Wilcoxon that used to measure the significant differences for small samples. The differences were found to be in favor of the posterior measurements.

Table 1: Differences in physiological and biochemical status of the players prior and posterior the training program

Variables	Groups	No. of samples	Mean of ranks	Sum of ranks	z-test
Resting heart rate	Negative ranks	24	12.5	300	4.301
	Positive ranks	0	0.0	0	
	Total	0			
Effort heart rate	Negative ranks	24	12.5	300	4.300
	Positive ranks	0	0.0	0	
	Total	0			
Resting lactic	Negative ranks	24	12.5	300	2.060
	Positive ranks	0	0.0	0	
	Total	0			
Effort lactic	Negative ranks	24	12.5	300	4.290
	Positive ranks	0	0.0	0	
	Total	0			

Test was used to determine whether the two population means are different at $p \leq 0.05$

Table 2 shows the positive change of physiological and biochemical status and their effect on the change of physical status of the players, where there are significant differences between the measurements before and after application of training program on the physical status. The posterior measurements were significantly better than the prior measurements, as indicated by the values of z-test.

As confirmed in Table 3, there were remarkable improvements in pulse rate at rest by 38.36% and pulse rate after the effort by 8.18%, prior the application of training program. This confirms the first hypothesis and in consistent with the study of Omar (1991), who reported decrement in pulse rate at rest. The same was previously reported by Alonso *et al.* (2003) and Ronald and Shirreffs (1996). There are significant differences in heart pulse rate, where the changes in the training intensity led to changes in the heart pulse rate that changed according to the level of competition. Savas *et al.* (2007) and Bishop (2005) found that the changes in the level of the pulse rate after violent exercise lead to increase in the respiration rate during the training because of the

Table 2: Variation in physical performance prior and posterior the application of training program

Variables	Groups	No. of samples	Mean of ranks	Sum of ranks	z-test
Endurance	Negative ranks	24	12.5	300	4.296
	Positive ranks	0	0.0	0	
	Total	0			
Speed endurance	Negative ranks	24	12.5	300	4.299
	Positive ranks	0	0.0	0	
	Total	0			
Leg strength	Negative ranks	24	12.5	300	2.290
	Positive ranks	0	0.0	0	
	Total	0			
Chest strength	Negative ranks	24	12.5	300	4.293
	Positive ranks	0	0.0	0	
	Total	0			
Leg power	Negative ranks	24	12.5	300	4.297
	Positive ranks	0	0.0	0	
	Total	0			
Arm power	Negative ranks	24	12.5	300	4.291
	Positive ranks	0	0.0	0	
	Total	0			
Trunk flexibility	Negative ranks	24	12.5	300	4.292
	Positive ranks	0	0.0	0	
	Total	0			
Shoulder flexibility	Negative ranks	24	12.50	300	4.301
	Positive ranks	0	0.0	0	
	Total	0			

Test was used to determine whether the two population means are different at $p \leq 0.05$

Table 3: Variation in physiological and biochemical variables prior and posterior application of the training program

Variables	First test	Final test	Change (%)
Resting heart rate	75.60	64.60	38.36
Effort heart rate	151.60	139.20	8.18
Resting lactate	1.45	1.03	28.97
Effort lactate	8.18	6.06	25.92

increasing in the heart rate and this means increasing the efficiency of the circulatory system and improving the ability of the heart to push the blood more efficiently (Rowell, 1996).

The changes in the rate of accumulation of lactic acid in blood in the resting state changed by 28.97% from that in the prior measurement and the rate of accumulation of lactic acid in blood after the effort changed by 25.92% from that in the prior measurement and this confirms the second hypothesis (II). This is in consistent with the results of Kirwan *et al.* (1988) and Mark (1996). Lactic acid changes with increasing the effort of training, which accompanied with increasing in the efficiency of the circulatory system to get rid of lactic acid accumulated in muscle as a result of the effort in training.

Regarding the physical variables, Table 4 shows the improvement in endurance of respiratory rate by 18.61% after the application of training program and this achieved the first goal and confirms the third hypothesis. The improvement in speed endurance by 27.73% compared with the prior measurement led to achieve the second goal and confirm the fourth hypothesis. The muscle strength of the two legs increased by 60.92% in comparison with that of prior measurement. Also, muscle strength of the chest improved by 62.26% from the prior measurement and this led to achieve the third goal and confirm the fifth hypothesis. Finally, the power of muscle of the two legs improved by 44.97% compared to the prior measurement. Moreover, the power of arm muscles increased by 57.73% from that prior measurements and this achieves the fourth goal and confirm the fourth hypothesis, as well as improved the flexibility of the trunk by 97.95 % from that prior measurements and improved the flexibility of the shoulders by 26.51% from that prior measurements and achieved the fifth and seventh goal.

Improvement in pulse rate at rest increased by 38.36%, this means that the number of heart beats decreased suggesting that the ability of the heart to pump blood increased efficiently; this rate of increment will supply the muscles with sufficient blood to remain at the same level of performance, while reducing the burden on the heart (Mora, 2006). This is one of the important vital signs, which refer to the efficiency of the process and that training is leading to improvements in heart pulse rate at rest. Also improvement of the heart pulse rate after the performance of the physical effort increased by 8.18%, this means that person during exerting physical effort can increase the efficiency of blood supply, which reaching the muscles at the same rate. Therefore, the heart is burden less upon during the performance of physical effort.

The rate of lactic acid in the blood at rest changed by 28.97% (Table 3), indicating that the rate of metabolism improves. This helps improving the critical situation of the person at rest. The rate of lactic acid in the blood after a physical effort increased by 25.92% (high percentage), also indicates that the catabolism is giving out energy, leading to increment in energy production, while

Table 4: Differences in physical variables prior and posterior application of training program

Variables	First test	Final test	Change (%)
Endurance	17.36	14.13	18.61
Speed endurance	10.79	8.23	27.73
Leg strength	87.00	140.00	60.92
Chest strength	53.00	86.00	62.26
Leg power	33.80	49.00	44.97
Arm power	204.80	312.80	57.73
Trunk flexibility	9.80	19.40	97.95
Shoulder flexibility	62.60	46.00	26.51

reducing the waste of energy production in the form of lactic acid, by almost the same percentage. This in turn led to increase the person's ability to perform physical effort while reducing the degree of fatigue by a quarter.

The endurance was also improved by 18.61% (Table 4), due to improvement of the blood and reduction of the rate of accumulation of lactic acid in the blood. Thus gives both circulatory and the respiratory muscles the opportunity to supply larger amounts of blood and oxygen. Correspondingly, this improves the level of speed tolerance by 27.73%. The efficiency of the physical abilities, which affected by the endurance, reflects better situation of physiological and biochemical status and improvement in the overall performance of the players.

Improvement in the strength of the large muscles of the chest and muscles of the legs by 60.62% was occurred, which is very large percentage compared to any training program affects the muscles. This indicates that the improved condition of the circulatory system and respiratory system necessarily led to improvement of the muscular system. Therefore, both systems directly affect the skeletal muscles system in general (Pauletto, 1994; Delavier, 2001). Also, improvement of physical ability of the muscle is important and necessary (at rate of 57.73%), which is the approach to improve muscle strength; this reflects the combination action of each other. Also indicates improvements in the physiological and biochemical situation that have direct impact on improving physical abilities such as flexibility and mobility of the trunk and shoulders, as well as the power and other abilities.

Improvement in flexibility is noted to improve flexibility and mobility of the trunk and shoulders. Improving the work of many vital organs is carried out by supplying the athletes with training program, based on scientific grounds. It can be noted that improvements of the players is primarily due to the status of training that they are following and is also affected by the nature of the training program applied and also, on which phase the training programs will be applied during the season of competition. Effects of these training programs usually allow the improvements in vital physiological and biochemical status, which are very important indicators to improve the physical condition and that is the basic goal of effective training programs.

CONCLUSION AND RECOMMENDATION

The present investigation concludes that there is urgent need to develop training programs to improve endurance of the respiratory system of the players during the preparation period before starting to improve any of the other physical abilities, also application the periodic respiratory endurance program must be followed by the application of speed endurance program, since both of them are complementary to each other. Completing the training strategy for the physical preparation programs to develop muscle strength is necessary to improve the level of muscle capacity.

Further studies must be carried out to find out the effect of changing the intensity of training on physiological variables and physical health, also to study the effect of violent exercises on the rate of breathing. These studies will be used to conduct further studies and researches that examined the efficiency of the circulatory system to get rid of lactic acid accumulated in muscle by exerting physical effort in training for a long time.

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