CHANGE IN THE FUNCTIONAL ABILITIES, AFTER THE INFLUENCE OF MAXIMAL PHYSICAL LOAD IN THE COMPETITION PERIOD IN FEMALE VOLLEYBALL ATHLETES FROM THE REPUBLIC OF KOSOVO

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Abstract

Heart rate and blood lactate concentration are appropriate parameters for assessing the intensity of the effort that players must endure during a match. Athletes, coaches and scientists in the sport have a keen interest in monitoring and measuring the body's adaptations produced as a result of training. For this reason, methods are used that provide reliable information about the athlete's performance during a match or training, intensive training is used to achieve the desired metabolic, cardiovascular and neuromuscular adaptations, in order to increase their physical capacity. The aim of this study was to assess the level and differences of functional abilities in female volleyball players during training in the competition period, through: maximum oxygen consumption (VO2max), calculated by applying the Beep test until dismissal. Heart rate before start of training (HRP) and during maximum load (HRK), blood lactate level, before training (KLPO) and after maximum load (KLKO). The research was conducted on a stratified sample of three sub-samples of respondents, 20 female volleyball players, members of the three first-ranked teams from the first volleyball league of the Republic of Kosovo. For each variable, the basic descriptive statistical parameters were calculated separately; Arithmetic mean (Mean), standard deviation (SD), lower and upper limit of results (±). To determine the intergroup differences, a multivariate analysis of the variance (MANOVA) and a univariate analysis of the variance (ANOVA) were used to test the differences between arithmetic means for each variable. For determining of the special influence of each variable in creating the differences in the groups a LSD test post hoc analysis was applied. Based on the Wilks' Lambda (0.099) and Raos F-approximation (3,401), a statistically significant difference was found between the three groups in the functional abilities at the level of $p = 0.005$.

Keywords: Volleyball - Heart rate - Blood lactate

Introduction

Due to the specific nature of the volleyball game, which is manifested by a limited time of contact with the ball, the need to perceive the essential events and quick reaction are crucial throughout the game, especially during matches (Mroczek, D., et. al. 2011). The high speed of the ball during the attack, to which the players in the defense have to react at a short distance (5-8 m) is the reason why the predictive abilities (anticipation) and the quick reaction by the players are im-

portant in volleyball. The introduction of the "libero" position has led to significant changes in the structure of the game, as well as greater specialization of players, both those who play in the new position "libero" and those players whose functions have changed, the central players. These changes have caused some confusion in the world of volleyball, mainly due to a lack of knowledge about their consequences for the players' performances. In this sense, heart rate and blood lactate concentration are appropriate parameters for assessing the intensity of the effort that players must endure under the new rules (C.González., et. al. 2005). Athletes, coaches and scientists in the sport have a keen interest in monitoring and measuring the body's adaptations produced as a result of training. For this reason, methods are used that provide reliable information about the athlete's performance during a match or training, intensive training is applied to achieve the desired metabolic, cardiovascular and neuromuscular adaptations, in order to increase their physical capacity (Hughson and Shoemaker, 2015; Stanley, Peake and Buchheit, 2013). In some volleyball studies, heart rate (HRV) is used as an indicator to measure the impact of a long training process (TL) generated by athletes, while others apply adequate measurements, comparing changes caused by training, so the data should to be announced throughout the season, increasing the number of measurements after matches (Germán Hernández-Cruz et. al. 2005). Variability of the heart rate (HRV) is a physiological phenomenon that is a measure of changes in heart rate at intervals of electrocardiographic intervals (R-R) in the electrocardiogram (Robert Podavski., et. al. 2014). Numerous publications also suggest that resting heart rate is lower in people who participate in sports than in physically inactive people (Shin K., et. al. 1997). Many psycho-physiological models consider heart rate (HRV) to be a source of non-invasive information about the balance between the impact of sympathetic and parasympathetic heartbeats (VR) at rest or during physical activity (Applehans B.M., Luecken L.J. 2006).

The assessment of the physiological load by observing the level of the concentration of lactic acid in the blood, allows to establish the participation of various metabolic systems in the production of energy necessary for the required type of load. Blood lactates also offer the opportunity to establish a link between blood lactate levels and load intensity. A relationship that is determined by the athlete's performance capacity in terms of aerobic and anaerobic energy (Navarro F. 1998). Lactic acid (La) levels increase during short workouts with maximum strength, during which oxygen deficiency occurs. It is known that high blood lactate levels are a limiting factor during exercise. Also, the increase in lactic acid prevents muscle contraction, which contributes to the acceleration of fatigue (Klapcinska B, et al. 2001). The most effective method for determining the anaerobic threshold is to measure the concentration of lactates in the blood, periodically during exercise (Yoshida T., et. al. 1981). The research focused on changes in heart rate (HRP) and blood lactate concentration (La) during maximum load during the competition period. The need for assessment of these parameters is due to the fact that fatigue, as a psycho-physiological condition, exists on two levels: 1) peripheral - metabolic changes in the performance of muscles that limit performance (Fitts 1994); 2) central-changes in the central nervous system that affect motor and perceptual processing, and are extremely important in the participation of ball games in top athletes (McMorris T, Graydon J., 1997; Royal et al., 2006).

Material and Methods

The aim of this study was to assess the level and differences of functional abilities in female volleyball players during training in the competition period, through: maximum oxygen consumption (VO2max), calculated by applying the Beep test (Beep t) until dismissal. Heart rate before start of the training (HRP) and during maximum load (HRK), blood lactate level, before training (KLPO) and after maximum load (KLKO). The research was conducted on a stratified sample of three sub-samples of respondents, 20 female volleyball players, members of the three first-ranked teams from the first volleyball league of the Republic of Kosovo. Polar Team, Polar Electro 2020 was used to measure heart rate, while Lactate Scout 4 Lactate Analyzer for Athletes, EKF diagnostics, was used to measure blood lactate levels. For each variable, the basic descriptive statistical parameters were calculated separately; arithmetic mean (Mean), standard deviation (SD), lower and upper limit of results (±). To determine the intergroup differences, a multivariate analysis of the variance (MANOVA) and a univariate analysis of the variance (ANOVA) were used to test the differences between arithmetic means for each variable. To determine the special impact of each variable in creating group differences, the LSD test post hoc analysis was used.

Results

The results of this study regarding the maximum oxygen consumption (VO2 max) in female volleyball players are shown in Table 1. From them it can be concluded that the female volleyball players from the first-ranked team have the highest values of the arithmetic means of VO2 max (Mean = 40,38 ± 6,55). Analogous to this result, the values of beep test (Beep t) (Mean = 2,57 ± 1,13) are the highest. As for the other two teams, the second-ranked team has the lowest values of the arithmetic means of VO2 max (Mean = 31,18 ± 2,20) and Beep t (Mean = 0,71 ± 0,75), while the volleyball players from the third-ranked team have something higher values of the arithmetic means of VO2 max (Mean = 33,85 ± 2,74) and Beep t (Mean = 1,16 ± 0,40). The obvious difference between the first-ranked team and the other two speaks to its better physical fitness. These results are moving within the available research from the literature. Table 2 shows the results for heart rate before the maximum load (HRP) and after the maximum load (HRK) in female volleyball players from the three teams. The first-ranked volleyball players have the highest values of the arithmetic mean of HRP (Mean = 129,28 ± 7,86), and the lowest values of HRK (Mean = 186,57 ± 40,06). In the second-ranked team, it is evident that it has the lowest values of the arithmetic mean of HRP (Mean = 120,71 ± 12,31) and the second largest values of HRK (Mean = 192,71 ± 5.40). The third-ranked team has similar HRP values (Mean = 128,00 ± 8,36) and the highest HRK values (Mean = 203.66 ± 4.58). Analyzing the results, it can be concluded that the female volleyball players from the first-ranked and third-ranked team, devoted more time and attention to warming up in order to bring the organism to the working level for maximum load, which is why their HRP values are similar. As for the values of HRK, the first-ranked team achieved the lowest values of HRK, which is another fact that the volleyball players from this team are physically the most prepared. The volleyball players from the third-ranked team achieved the weakest results in the arithmetic means of HRK. The HRK values obtained are in accordance with the available literature.

Table 1. Descriptive Statistics of the maximal oxygen consumption

	Variabels	Mean	Min	Max	SD
First team (n=7)	VO2 max	40,38	34	53,50	6,55
	BeepT	2,57	1,00	4,00	1,13
Second team (n=7)	VO2 max	31,18	27,20	32,90	2,20
	BeepT	0,71	0,00	2,00	0,75
Third team (n=6)	VO2 max	33,85	30,30	38,10	2,74
	BeepT	1,16	1,00	2,00	0,40

Table 2. Descriptive Statistics of Heart rate

	Variabels	Mean	Min	Max	SD
First team (n=7)	HRP	129,28	120,00	140,00	7,86
	HRK	186,57	97,00	210,00	40,06
Second team (n=7)	HRP	120,71	98,00	140,00	12,31
	HRK	192,71	188,00	203,00	5.40
Third team (n=6)	HRP	128,00	120,0	140,00	8,36
	HRK	203.66	196,00	208,00	4.58

From the analysis of the results in Table 3, which refer to the level of blood lactates before the maximum load (KLTO), and after the maximum load (KLKO) in female volleyball players from the three teams, the following can be concluded: the lowest level of arithmetic mean of blood lactates before the maximum load was registered in the volleyball players from the third-ranked team (KLTO = 3,20 ± 2.22) in relation to the first-ranked team (KLTO = 3,45 ± 2,94) and the second-ranked team (KLTO = 4.52 ± 2,18). By measuring the level of blood lactates after the maximum load, the volleyball players from the second-ranked team showed the lowest values of the arithmetic mean of the level of blood lactates (KLKO = 9.01 ± 3.8). The female volleyball players from the first-ranked team achieved a slightly higher level (KLKO = 11.05±1.33), while the volleyball players from the third-ranked team achieved the lowest values (KLKO = 14.11±3,46). The results obtained are within the scope of available research.

Table 3. Descriptive Statistics of the level of blood lactates

	Variabels	Mean	Min	Max	SD
First team (n=7)	KLTO	3,45	1,80	9,90	2,94
	KLKO	11.05	8,30	12,20	1.33
Second team (n=7)	KLTO	4.52	1,40	7,30	2,18
	KLKO	9.01	6,80	10,60	1.46
Third team (n=6)	KLTO	3,20	1,50	7,40	2.22
	KLKO	14.11	8,80	19,40	3,46

Table 4. Multivariate Tests of Significance Sigma-restricted parameterization Effective hypothesis decomposition

	Test	Value	F	Effect - df	Error - df	p
Intercept	Wilks	0,000	3410,190	7	11	0,000
NewVar	Wilks	0,099	3,401	14	22	0,005

From the values shown in Table 4, and referring to the statistically significant differences between the three groups of volleyball respondents, it can be concluded that: based on the Wilks Lambda (0.099) and the Raos F approximation (3,401), there is a statistically significant difference between the three groups in the functional abilities at the level of p = 0.005.

Table no. 5 represents the differences at the Univariate level, ie the variables that contribute to the creation of the statistically significant difference within the groups. From the same it can be seen that in the variable VO2 max a statistically significant difference was determined at the level p = 0.003, as well as in the variable Beep test (Beep t, p = 0.001) which is the basis for calculating VO2 max. Concentration of lactates after maximum load (KLKO) also contributed to the creation of statistically significant differences at the level of p = 0.002. Although numerical differences were found in variables for measuring heart rate HRK and HRP before and after the maximum load, as well as in KLTO lactate levels before the maximum load, no statistically significant differences were found.

Table 5. Analysis of Variance Marked effects are significant at p < ,05000

	SS - Effect	df - Effect	MS - Effect	SS - Error	df - Error	MS - Error	F	p
VO2 max	311,977	2	155,988	324,572	17	19,092	8,170	0,003
BeepT	13,024	2	6,511	11,976	17	0,704	9,243	0,001
HRP	294,943	2	147,471	1630,857	17	95,932	1,537	0,243
HRK	958,074	2	479,036	9910,476	17	582,969	0,821	0,456
KLTO	6,658	2	3,329	105,711	17	6,218	0,535	0,595
KLKO	84,554	2	42,277	83,614	17	4,918	8,595	0,002

Tab.6. LSD Test; Var VO2 max Marked differences are significance are significant at p<,005

Var	Group	mean 40,386	mean 31,186	mean 33,850
VO2 max	1,0		**0,00**	**0,01**
	2,0	**0,00**		0,29
	3,0	**0,01**	0,29	
	Group	**mean 2,57**	**mean ,71**	**mean 1,16**
Beep T	1,0		**0,00**	**0,00**
	2,0	0,00		0,35
	3,0	0,00	0,35	
	Group	**mean 11.05**	**mean 9.01**	**mean 14.11**
KLKO	1,0		0,10	**0,02**
	2,0	0,10		**0,00**
	3,0	**0,02**	**0,00**	

To determine the contribution of each variable separately in the formation of intergroup differences, while not making a series of t-tests that in turn can generate errors, LSD test Post hoc analysis was used.

By inspecting the tables in which the LSD test Post hoc analysis is shown, statistically significant differences in the variable Vo2 max can be determined, between the first-ranked and second-ranked team at $p = 0.00$ and the first-ranked and third-ranked team at level $p = 0.01$. In the beep test (Beep t) variable, statistically significant differences were found at $p = 0.00$ between the first-ranked team and the other two teams. In the variable concentration of lactates after maximum load (KLKO), statistically significant differences were determined at the level of $p = 0.02$, between the first-ranked and the third-ranked team, the second-ranked with the third-ranked team at the level of $p = 0.00$. The other three variables, in which numerical differences are determined, still do not participate in the creation of statistically significant intergroup differences with their values.

Discussion

In sports that needs to be played indoor (gyms), the performance of athletes is generally determined by the time of play and the pace of play. In response, training programs aim to slow down the time it takes to form fatigue and improve endurance against fatigue (Ismail KAYA et. al 2013). Volleyball is a sport that is characterized by a wide range of movements and the amount of energy consumed, which are exchanged during the competition, and the energy is drawn from both aerobic and anaerobic metabolism.

Heart rate is an indicator of the intensity of the player's activity in each sport. It is considered to be the best indicator because it is directly related to the amount of oxygen the player consumes. According to the linear relationship between V02 and heart rate, oxygen consumption is enhanced when heart rate increases (McArdle et. al, 1986). This relation was also used in this study to determine the level of oxygen consumption and lactate values in the blood as a result of maximum load. The values for the maximum oxygen consumption published in the literature, for elite male volleyball players, range from 43.2 ± 5.2 to 65.2 ± 6.1 ml.kg-1.min-1 (Kasabalis, 2005). The results of our study showed that the real values for the maximum oxygen consumption of female volleyball players range from 40.38 ± 19.58ml.kg-1.min-1 to 31.18 ± 5.7ml.kg-1.min-1. If we take into account that our study was about female volleyball players, and that volleyball in Kosovo is not at the European level, it can be said that the results of some female volleyball players from the first two teams are satisfactory compared to the results of the literature. Based on the results shown, the female volleyball players from the two first-ranked teams have a satisfactory level of aerobic ability, and they use less oxygen during the competition compared to the measurement of the maximum load. During the competition, the volleyball players do not reach the maximum level of load, and one set lasts more than 20 minutes, and the volleyball players need energy resources for at least three sets. The heart rate values measured in this study are consistent with the literature values (Kasabalis, 2005). In our study, differences in heart rate (HRP) and blood lactate concentration lev-

els (KLTO) before the maximum load, are relatively small, can be explained by the individual commitment of each volleyball player in the warm-up before testing.

The concentration of lactates in the blood is an important tool for determining endurance capacity and maintaining control of exercise (Foster C, et. al. 1993). The level of lactates in the venous blood [La ±] significantly increases with increasing intensity of exercise in a short period of time. This result can be explained by the activation of milk anaerobic metabolism, which participates in energy production and / or phospho-creatine re-synthesis used in such a short interval of exercise (K. Chamari at. All. 2001). In our study, the values of blood lactate concentrations after the maximum load range from 9.01 ± 3.8 to 14.11 ± 10.6, which are results similar to the results obtained from the literature.

Conclusion

Athletes' functional abilities can play a crucial role in achieving top form, and thus achieving ultimate sports success. That was more of a reason to conduct research with 20 female volleyball players from the top three teams in the Kosovo Volleyball League. Laboratory studies to assess blood lactate accumulation often use a fixed-time protocol to define the onset of lactate accumulation in the blood or other indicators of blood lactate concentration. For practical reasons, field studies with athletes often use a fixed distance protocol to achieve the same goal (Foster C, et. al. 1993).

Measuring heart rate (HRV) during different periods of the training process can be very helpful in assessing the effectiveness of training in volleyball, due to the fact that changes in HRV can be of prognostic value, and potentially reduce the risk of overtraining. There is strong evidence that heart rate (HRV) measures what needs to be measured. The analysis of the applied variables in the research, largely gives a clear picture of the monitoring of the sports form in athletes. This is an attempt that should give a positive view of the programming and creation of the top form.

The main limitation of our study is the relatively small number of respondents, which reduces the power of statistics. However, it should be borne in mind that this is mainly due to the specificity of the discipline, because the number of volleyball players who make up the core of the volleyball team and who train under the supervision of one coach and in the same conditions, is always limited and rarely which team exceeds 8 volleyball players. Therefore, it is advisable to conduct other research involving volleyball players from other volleyball teams, and which will be conducted according to our research methodology. This type of research is desirable to do, by expanding the segments of the research, and in other macro cycles of the training process.

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