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The effect of the prolonged competitive season on semi-elite female volleyball players' physical performance

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Abstract

Despite the literature on the changes in the physical performance characteristics of elite female athletes during the competition period, up to this date, there was no study of the physical performances of both the aerobic and anaerobic contented of the semi- elite female volleyball players over the competitive season. For this reason, this study was carried out in order to determine the effect of prolonged competitive season on semi-elite female volleyball players' physical performance. Volunteer 47 athletes were recruited from same group of division III in Turkey Women Volleyball League. During competitive season, athletes took part in an official match and 3-4 training seasons per week. Body mass, VO_2 max, 20m sprint, agility, vertical jumping, explosive power, aerobic and anaerobic power were assessed before and after 22-week competitive season. Normality data was primarily tested with Shapiro-Wilk and evaluated with Wilcoxon test because of abnormal distribution. There was significant improvement in VO_2 max (2.26%), 20 m sprint time (2.1%), agility (1.6%), vertical jump (2.99%), explosive power (3.5%), maximal anaerobic power (6.35%), whereas decrease in minimum (-5.8%) and average anaerobic (-30.66%) power ($p<0.05$), but decrease in body mass wasn't significant. This study indicated that prolonged competitive season had negative effect on anaerobic capacity and positive effect on agility, sprint, VO_2 max, vertical jumping and explosive power in the semi-elite female volleyball players.

Key Words: Aerobic, Anaerobic, Agility, Sprint, Volleyball

INTRODUCTION

Volleyball is a sport that is performed in short bouts of high intensity its specific technical movements such as spiking, blocking, serve and passing (21). These movements which affect significantly match performance require players to have well developed physical performance characteristics such as sprint, agility, jumping, aerobic and anaerobic power (15, 23). Therefore, in preparation period, the development of physical performance characteristics is the main objectives of players (2). However, these characteristics are likely to change during the prolonged competitive season due to its technical and tactical training with high volume (25).

Some researchers studied on the physical performance of elite volleyball players during the competition period (7,19). Regarding this, Loomis (19) reported that there was no significant change in the anaerobic physical fitness of elite male college volleyball players during the competition period. Koutedakis (13) indicated that in elite athletes, anaerobic parameters remain relatively unchanged but aerobic performance tends to decrease throughout the season. Hakkinen (7) pointed out that elite women volleyball players' anaerobic performance characteristics significantly declined over the season. In other study, Newton et al. (25) reported that, jump performance, many of the measures relating to high velocity, power actually and acceleration ability of elite female volleyball players decreased in the first seven weeks of the 11-week competition period. However, during the ballistic training period, the strength, sprint, and power production during the various jump tasks increased, all values that had decreased during the first 7-week recovered or even exceeded the values at the start of the season. They also stated that significant decreases weren't observed and in any of the measured variables during 4-week ballistic training period, and variables of all tested did not change significantly between the start and the end of the season (25). In addition, some researchers (6, 23) have noted that the training to improve strength and power during the competition period significantly increases the anaerobic parameters of volleyball players. It has been reported thatdecreases can occur

in physical performance characteristics of team athletes due to high volume technical-tactical training and competitions during the prolonged competitive period (14), but these negative changes can be prevented with well-planned specific training (25).

Knowing the changes in the physical performances of semi-elite female volleyball players during the competition period can make a significant contribution to the reorganization of the training programs of coaches and athletes working in this area. Regarding during the competition period, although there are studies on the elite women volleyball players, up to date, there has been no study of the physical performance's change that contend both the aerobic and anaerobic of the semi-elite female volleyball players. Therefore, the purpose of the study is to determine whether semi elite women volleyball players' physical performance characteristics have changed during the prolonged competitive season.

METHODS

Subjects

Seventy-two Turkey Volleyball Federation Division III female volleyball players from the same group of 11 different teams volunteered to participate in this study in the beginning of the competition period. 47 athletes (mean age and height: 22.38 + 1.97 years, 172.66 + 4.1 cm, respectively) who were at least 70% of both competitions and training were recruited in the final tests. All participants were informed of the risks and benefits of the study, and signed an informed consent document and asked the athletes to act according to the rules of the tests.

Competitions and Trainings: During the 22-week competition period, the athletes participated in an official match at a week, and technical-tactical training and specific or traditional conditioning program, which was 3 or 4 days a week and 90 or 120 min per day. The number and percentages of the durations of the training were depicted in Table 1, by analysing according to the information by the team coaches.

Table 1. Seasonal Match and Training Program

Number of Match	Number of Training	Total Duration of Training (min)	Technical and Tactical Training (%)	General Conditioning (%)
20	66-80	7200-8500	60-70	30-40
Mean	73	7850	65	35

Testing Protocols

Each player was tested on two separate non-consecutive days and all tests were completed within two weeks for before and after the competitive season, and athletes were allowed their standard warm up prior to tests. On the first day, as well as the age, height and body mass, 20-meter multistage shuttle-run fitness and vertical jump tests were performed. On the second day, agility, 20-meter sprint and Running Anaerobic Sprint (RAST) tests were conducted.

Aerobic Power (VO_2max) Test: The athletes ran in a straight line to axis upon completing, and proceeded according to the given sound signals. The test was finished when the players stops or fails to reach the end lines concurrent with the audio signals on two consecutive occasions. Estimated VO_2max values were calculated using the method of Leger et al (16).

Vertical jump and explosive power test: The vertical jump heights of the athletes were tested by using the Vertec tool. Three repetitions with 1-min rest interval were carried out, and the best data were formulated to determine explosive power values as watts (10).

Agility Test: The test (T) was carried out to determine the speed and change of direction such as forward sprinting (10 m), left and right shuffling (20 m), and backpedalling (10 m) that was described by Pouole et al (27). The best performance of the two non-consecutive trials was recorded.

20m Sprint Test: Accelerations were evaluated using 20 m sprint test. Players ran as fast as placed on a straight line marked on the floor from a standing position. The recorded time for this test was the better of the two last trials.

Anaerobic Power Test: Anaerobic power was determined with the RAST protocol. Players were performed six 35-m maximal sprints with a 10 sec interval between each sprint. Each sprint time was measured by two photocells equipment. the power in each sprint was then calculated by the formula that was determined by Zagatto et al (31).

Statistical Analysis

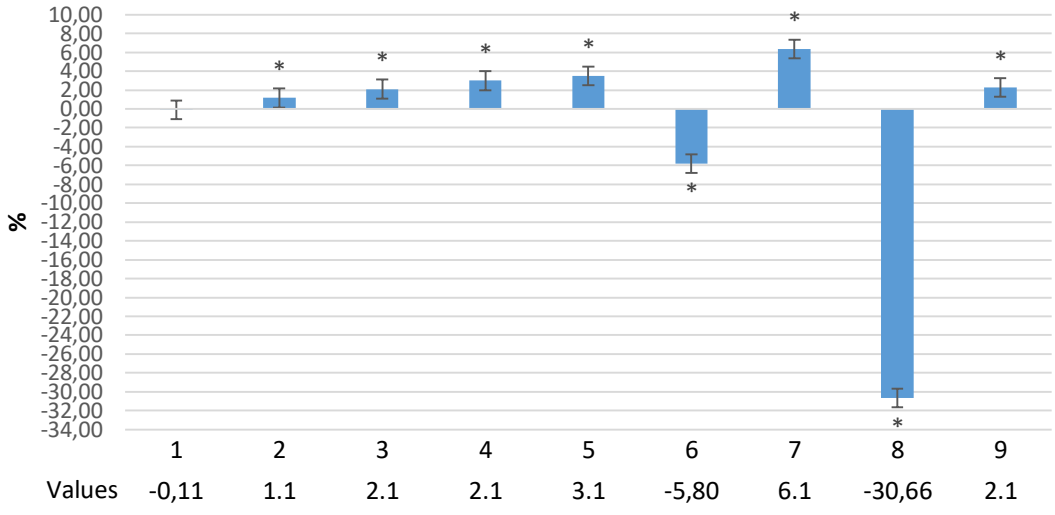
Statistical analysis was performed in SPSS software version 23.0. All data were computed as means and standard deviation (SD), and tested for normality using Shapiro-Wilks test. Wilcoxon test was then employed to evaluate for the statistical significance of differences pre and post-tests differences since the data didn't show normal distribution. Significance level was set at $p<0.05$ for all data. Cohen's d effects sizes (d ~ 0.2, ~ 0.5 and ~ 0.8, small, medium and large, respectively) based on standardized differences between mean scores were calculated to examine the magnitude of such differences (24).

RESULTS

Table 2. Changes of Semi-Elite Female Volleyball Players' Physical Performance Characteristics over the Prolonged Competitive Season

		Mean	SD.	Difference	Effect Size	Z	P
Body Mass (kg)	Pre Test	60.98	6.20	-0.07	-0,01	0,410	>0.05
	Post Test	60.91	5.88				
Agility (sec)	Pre Test	13.10	0.81	-0.15	-0,19	5,974	<0.05
	Post Test	12.95	0.74				
20m Sprint (sec)	Pre Test	4.37	0.41	-0.09	-0,22	5,976	<0.05
	Post Test	4.28	0.39				
Vertical Jump Height (cm)	Pre Test	37.85	5.93	1.13	0,19	5,315	<0.05
	Post Test	38.98	5.31				
Lower Body Explosive Power (watt)	Pre Test	1182.20	252.80	42.82	0,17	4,645	<0.05
	Post Test	1225.02	224.68				
Mean Anaerobic Power (watt)	Pre Test	368.56	46.98	-20.3	-0,45	4,541	<0.05
	Post Test	348.26	41.32				
Max Anaerobic Power (watt)	Pre Test	443.95	75.64	28,2	0,39	4,445	<0.05
	Post Test	472.15	65.88				
Min Anaerobic Power (watt)	Pre Test	293.16	42.67	-68.8	-1,61	4,541	<0.05
	Post Test	224.36	37.09				
VO_2max (ml/kg/min)	Pre Test	41.63	3.35	0.94	0,29	4,547	<0.05
	Post Test	42.57	3.02				

Figure. Percentage of pre and post-test differences



1=*Body mass*, 2=*20 m sprint*, 3=*Agility*, 4=*Vertical Jump*, 5=*Explosive power*, 6=*Average anaerobic power*, 7=*Maximal anaerobic power*, 8=*Minimal anaerobic power*, 9=*VO_2max*

Differences in pre and post-tests and their percentage were shown in the table 2 and figure 1, respectively. Differences in pre and post-tests of 20 m sprint, agility, vertical jump, explosive power, maximal aerobic and anaerobic powers were significant ($p<0.05$), but changes in body mass were not important. There were significantly increase in agility (1.16%), 20 m sprint (2.1%), vertical jump (2.99%), explosive power (3.5%), maximal anaerobic power (6.35%) and VO_2max (2.26%). However,

significant decreases were observed in mean and minimal anaerobic (-5.8%, -30.66%, respectively) powers ($p<0.05$). When the effects of changes in physical performance of female volleyball players were examined, it was observed that these effects were close to the medium on mean and minimal anaerobic powers, while other characteristics tested were small values according to Cohen's d criteria (Table 2).

DISCUSSION

In this study, it was aimed to determine the effects of the prolonged competitive season on the semi-elite female volleyball players' physical performance characteristics. For this purpose, there were some limitations which could affect the result of the research such as voluntary participation to the tests, menstruation during the tests, participation in at least 70% of the competitions, to be competing in the same group and to ignore the training differences of team in the competition period. For this reason, 47 athletes were allowed to participate in the final tests, although 72 athletes initially participated in the tests. This study indicated that there were significant increases in VO_2max, 20m sprint, agility, vertical jump, maximal anaerobic and explosive powers of the semi-elite female volleyball players over the competition period ($p <0.05$). However, the mean and minimum anaerobic power values of the participants decreased significantly ($p <0.05$), but decrease in body weight was not matter.

There was a significant increase in the vertical jump height (2.99%) and the explosive power (3.56%) associated with it of the semi-elite female volleyball players, ($p <0.05$). These increases can be explained by the increase in the elastic energy in the elastic component of the muscle (1) and the frequency of stimuli that cause a high increase in strength produced biomechanically in the eccentric phase during jumping as a result of the intensity of the coordinated jumping movements performed by the athletes (18).

During a five-set volleyball match, although players perform a vertical jump (spike and block) of around 250-300 (9) depending on the athlete position in the field, the high coordination and frequency of these movements may not be possible. For this reason, improvements in the vertical jump and explosive power can be associated with jumping movements in the trainings rather than play. Regarding this, Vilamitjana (30), Marques (23) Gonzalez (6) and Rousanoglou (29) reported that there was a significant increase in the volleyball players' jump height and explosive power, thanks to the applied specific training. However, Hakkinen (7) and Newton (25) pointed out that if no specific training was applied, vertical jump height of the volleyball players would be significantly decrease in relation to the length of the competition period. Although a detailed examination of the players' training program content was outside the extend of this study, it was thought that the increase in the vertical jump height and explosive power values of female volleyball players was related to the training content and the players' trainability (22).

In this study, significant improvements were observed in the 20m sprint (2.1%) and agility (1.16%) of women volleyball players ($p<0.05$). To date, as far as we aware, no studies have been published on the change of volleyball players' sprint and agility related to the during prolonged competitive season. However, Gabbet (4) reported that skill-based training lead to significant improvements in the speed and agility of young volleyball players. Sprinting speed and agility, especially in the volleyball, is an integral part of the offensive and defensive manoeuvres. Therefore, it can be concluded that offensive and defensive exercises both in competitions and in training contribute to the development of players' sprint ability and agility (14,17).

In this study, significant increases in maximal anaerobic power and significant reductions in mean and minimal anaerobic powers were observed ($p <0.05$). In previous studies were reported different knowledge related to change of the athletes' anaerobic power throughout the competitive period. Hakkinen (7) reported that the anaerobic power of team athletes decreased significantly during the competition period while Pfeifer (28) did not change. However, Gabbet (4) and Eliakim (3) stated that there may be significant increases in anaerobic power depending on training content. Anaerobic power is under the influence of muscle enzyme activity (26) and cellular regulation. Maximal anaerobic power increase may be associated with an increase in sprinting speed and vertical jump (21). Anaerobic power is under the influence of muscle enzyme activity (26) and cellular regulation. Maximal anaerobic power increase may be associated with an increase in sprinting speed and vertical jump (21). However, decrease in the mean and minimal anaerobic power

can be explained by reductions of the anaerobic enzyme activity during the competition period and the fatigue increase due to the decrease in the acid buffer capacity of the skeletal muscle cells. (11). Although the volleyball required more anaerobic energy (20), the increase in the VO_2max value of the volleyball players who participate in this study were significant ($p<0.0$). This result consistent with studies of Haritonidis (8) and Vilamitjana (30). However, Hakkinen (7) reported that during volleyball competitive season estimated VO_2max of the players was no change significantly. Although volleyball game depends on anaerobic energy system (85-90%), aerobic metabolism (10-15%) is mostly used in resting intervals that when the ball is not in play or during time out to replenish phosphagens that are used to remove lactic acid which might be accumulated during match (5). Therefore, volleyball players and coaches generally do not apply any special training to improve the aerobic power in the competitive season. Nevertheless, aerobic metabolism could be developed with high or maximal intensity exercises that are repeated at regular intervals (12). So technical movements with high or maximal intensity frequently repeated during prolonged competition period might have contributed to the development of the players' aerobic capacities.

This study indicated that there was significant decrease in mean (-5.80%) and minimal anaerobic powers (% -30.66), and significant increase in 20m sprint (2.1%), agility (1.16%), vertical jump (2.99%), explosive power (3.5%), maximal aerobic (2.26%) and anaerobic powers (6.35%). However, although these increases were significant, it was seen that the effect sizes were small according to Cohen's d criteria. It can be concluded that the prolonged competition period has a negative effect on the lactate anaerobic endurance, but positive effects on the a-lactate anaerobic and aerobic characteristics of the semi-elite female volleyball players.

As stated in most of the above mentioned literature knowledge, change of the female volleyball players' physical performance characteristics during prolonged competitive season are related to the training programs in this process. For this reason, it may be thought that the results of this study are important for the athletes and coaches in this area in order to rearrange their training programs and practices. Additionally, it should be considered that the data of this research is a literature knowledge about the physical performance of semi-elite female volleyball players.

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