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Changes in physical performance characteristics of female volleyball players during regional division competitions

Cambios en las características de rendimiento físico de jugadoras de voleibol durante competiciones de división regional

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ABSTRACT

This study aims to examine the seasonal changes in the physical performance of female volleyball players competing in the regional division. Forty-three volunteer female players (age: 22 ± 2.1 years, height: 172.9 ± 4 cm, weight: 61.5 ± 6 kg, experience: 8.8 years) competing in the same group of the regional division of the Turkish volleyball league participated in this study. Players participated in a series of test protocols including the 20m shuttle-run, T-run, 20m sprint, vertical jump, and running anaerobic sprint (RAST) in the beginning, mid, and ending of the 16-week competition season. The results showed that all tested physical performance characteristics of the players improved significantly in both the first and second periods of the competition season. However, the improvements in the first period were significantly higher than in the second period for VO_{2max} (4.7 vs 1.5%, $p<0.05$), anaerobic power (6.6 vs 1.9%, $p<0.05$), vertical jump height (3.46 vs 1.54%, $p<0.05$), explosive power (4.48 vs 3.72%, $p<0.05$), 20-m sprint (2.4 vs 0.98%, $p<0.05$) and change of direction abilities (0.9 vs 0.7%, $p<0.05$). This study indicated that the prolonged competition season might induce significant functional improvements in the physical fitness profile of female volleyball players competing in the regional division.

KEYWORDS

Aerobic Performance; Anaerobic Performance; Change of Direction; Sprint.

RESUMEN

Este estudio tiene como objetivo examinar los cambios estacionales en el rendimiento físico de las jugadoras de voleibol que compiten en la división regional. En este estudio participaron 43 jugadoras voluntarias (edad: 22 ± 2,1 años, altura: 172,9 ± 4 cm, peso: 61,5 ± 6 kg, experiencia: 8,8 ± 1,8 años) que competían en el mismo grupo de la división regional de la liga turca de voleibol. Las jugadoras participaron en una serie de pruebas que incluían el test de ida y vuelta de 20 metros, T-test de agilidad, sprint de 20 m, salto vertical y carrera de sprint anaeróbico (RAST) al principio, a la mitad y al final de la temporada de competición de 16 semanas. Los resultados mostraron que todas las características de rendimiento físico evaluadas de las jugadoras mejoraron significativamente tanto en el primer como en el segundo período de la temporada de competición. Sin embargo, las mejoras en el primer período fueron significativamente más altas que en el segundo período para el $VO_{2máx}$ (4,7 vs 1,5%, p <0,05), potencia anaeróbica (6.6 vs 1,9%, p <0,05), altura del salto vertical (3,46 vs 1,54%, p <0,05), potencia explosiva (4,48 vs 3,72%, p <0,05), sprint de 20 m (2,4 vs 0,98%, p <0,05) y habilidades de cambio de dirección (0,9 vs 0,7%, p <0,05). Este estudio indicó que la temporada de competición prolongada podría inducir mejoras funcionales significativas en el perfil de condición física de las jugadoras de voleibol que compiten en la división regional.

PALABRAS CLAVE

Rendimiento Aeróbico; Rendimiento Anaeróbico; Cambio de Dirección; Sprint.

1. INTRODUCTION

Volleyball is a dynamic and intermittent team sport consisting of fast and short displacement movements, in which the speed, jumping and changes of direction are an integral part of the demands of the game. These demands require well-developed physical conditioning as they are necessary to succeed during volleyball competitions, although the requirements may vary depending on the level of competition of the athletes (Sheppard, 2009). Therefore, the capacity of athletes to acquire and maintain well-developed physical performance variables before and during the competition season is crucial for optimal performance.

Athletes aim to further improve or at least maintain the physical performance characteristics developed in the preparation period throughout the competition season (Ferioli, 2018; Marques, 2008). Nevertheless, increased match load and prolonged rallies can induce significant degradation in the physical performance characteristics of the players by increasing both physiological and psychological stresses that trigger fatigue (Haneishi et al, 2007). Despite the specific measures taken, there may be significant fluctuations in physical performance variables during the competition season depending on many factors such as the fitness level of the athletes, intensity of the competitions, training volume or content (Karahan, 2018; Koutedakis, 1995). A limited number of studies provide data that seasonal variations in the physical performance characteristics of female volleyball players competing in different playing level (Hakkinen, 1993; Karahan, 2018; Nesser and Demchak, 2007; Rousanoglou, Barzouka and Boudolos 2013). For example, Hakkinen (1991) and Karahan (2018) reported for elite and semi-elite female volleyball players, respectively that the seasonal reduction in anaerobic power and the increase in neuromuscular functions were significant. Additionally, Rousanoglou et al. (2013) reported significant improvements in the jumping performance and knee muscle strength of the single team junior female volleyball players during the competition season. On the other hand, some researchers (Fry et al, 1991; Gjinovci et al. 2017; Gonzales et al., 2011; Manna, Khanna and Dhara 2012; Newton et al, 2006; Purkhus, Krustrup and Mohr, 2016) examined the effects of training on seasonal changes in the physical performance characteristics of female volleyball players. Gjinovci et al. (2017) and Gonzales et al. (2011) reported that plyometric and strength training applied during the competition season increased the jumping performance of female volleyball players. Besides, Biçer (2020), Newton et al. (2006) and Purkhus et al. (2016) observed an improvement over the season in physical performance parameters of specific high-intensity training groups, whereas significant decreases in traditional training groups.

Although success in volleyball games is associated with many internal and external factors, it mostly depends on the development of the physical, physiological, and technical-tactical characteristics of players and their ability to perform them on the court throughout the season (Koutedakis, 1995). For this reason, the performance variables of the players should be monitored and followed throughout the season for optimal performance. To date, there is no comprehensive study on the seasonal changes in the physical fitness of female volleyball players competing in sub-divisions and whether these physical fitness variables differ according to the competition periods. Therefore, this study aimed to examine the seasonal changes in physical performance characteristics of female volleyball players competing in the same group in the regional division for both the first and second periods of the season, ignoring the effect of the teams' seasonal training programs. The results of this research may be important in terms of establishing a norm about the physical performance of female volleyball players competing in the regional division. In addition, providing indicative data according to the competitive levels of seasonal changes in the physical performance of female volleyball players may contribute to coach and conditioning trainers to evaluate the effectiveness of their training programs in different periods of the season.

2. METHODS

2.1. Participants

Initially, 70 female volleyball players from the same group of the regional division of the Turkish volleyball league volunteered to participate, but the data of 43 athletes (age: 22 ± 2.1 years, height: 172.9 ± 4 cm, weight: 61.5 ± 6 kg, experience: 8.8 ± 1.8 years) who took part in at least 75% of the total of both competition and training seasons were evaluated. All players and their coaches were informed about the study procedures, benefits, requirements and risks, and then written informed consent was obtained. The study procedures were approved by the Aksaray University Human Research Ethics Committee.

2.2. Procedures

This study was a repeated-measures design with measures carried out pre, mid and end of over the official competitive volleyball season for regional division. First of all, seven clubs and their volleyball team coaches from the same group of the regional division were contacted to provide information on the purpose of this study and its calendars, where physical performance tests would be conducted Secondly, the coaches and players of seven of the clubs that accepted the proposal were informed about the test calendars and rules. Coaches and players verbally declared that they approved the request to avoid excessive physical activities during test protocols and 48 hours before it's. The coaches were interviewed as to whether the players had any previous experience with the proposed testing procedures. Then, players became familiar with testing procedures as they were not available for prescription training purposes several occasions in previous seasons. Physical performance measurements were conducted on three occasions over a 16-week season, at the same times of the day (15: 00-17: 00) by seven volleyball coach candidates assigned for each team under the supervision of each team's coach. One week before the competition season the athletes performed in an indoor gym with a synthetic floor the shuttle run test on Tuesday, the 20-m sprint, T-run and the countermovement jump tests on Wednesday and the RAST test on Thursday. These tests were repeated within five days following the end of the first and second periods of the competition season. The players were allowed for the 10-minute general warm-up and 5-minute cool-down exercises before and after the test applications, respectively. All players were verbally encouraged and motivated by the coaches during the tests to achieve optimal data efficiency.

2.3. Seasonal program

During the competition season, which lasted 16 weeks at two-week intervals, players took part in a regular playing official match and an 80-90 minutes general training program three or four times per week, including technical-tactical and specific or general physical conditioning. The duration, the number of sets and scores of each volleyball match played were provided for analysis from the official report recorded by the referees of that match (Table 1).

Table 1. Seasonal variations of volleyball competitions for sets, scores and durations.

	Total Set numbers	**Mean Set numbers/match**	**Total Scores**	**Mean scores/match**	**Total Durations (min)**	**Mean Duration/match (min)**
First Period	74	3.66±0.7	3021	143.8±35	1812	86.31±21
Second Period	72	3.5±0.6	3060	145.8±24	1837	87.5±15
Total	146		6081		3649	

2.4. Physical performance tests

2.4.1. 20-meter shuttle runs

The aerobic power was determined by a 20-meter shuttle run test which was used to predict estimated VO_{2max} designed by Leger et al. (1988). Athlete runs in a 20-meter straight line with audio signals from an electronic device. The test terminates when the athlete either unable to reach the end of 20-meter designated line twice simultaneously with the audio signal or leaves voluntarily. The intra-class correlation coefficient for the test-retest reliability of the shuttle run test measurement was 0.97.

2.4.2. T-run

The change of direction (COD) ability of the players was determined by the T-run test. The test consists of the player's sprint ability, which includes changes in direction such as running forward, shuffling left and right, and running back to the starting line. The best of the two test performances, repeated twice with a 1-minute active recovery interval, was recorded using an electronic timing device located at the start line. The intra-class correlation coefficient for the test-retest reliability of the T-run test measurement was 0.99.

2.4.3. 20-m sprint

Each player ran two 20-meter sprints with one-minute recovery intervals at a high starting position. The best score read in the electronic timing system was recorded as sprint performance. The intra-class correlation coefficient for the test-retest reliability of the 20-m sprint test measurement was 0.92.

2.4.4 Vertical jump height

The test consists of a counter-movement vertical jump (CMJ) with the player's hands fixed on his waist. The jump height was measured with a vertimetric device fixed to the player's ankle. The best of three performances performed with 30-second rest intervals were evaluated as the vertical jump height and was also calculated the lower limb explosive power with the formulation determined by Johnson and Bahamonde (1996). The intra-class correlation coefficient for the test-retest reliability of the vertical countermovement jump-test measurement was 0.98.

2.4.5. The running anaerobic sprint test (RAST)

This test consists of a 6x35 meters sprint run with a 10-second active recovery interval allowed between each sprint for the turnaround. Measurements were carried out with two electronic timing system placed 35-m apart on the indoor synthetic surface. The 6x35-m running scores were calculated to determine anaerobic power in watts using the formula defined by Zagatto et al. (2009). The intra-class correlation coefficient for the test-retest reliability of the RAST test measurement was 0.96.

2.5. Statistical analyses

Descriptive statistics and statistical differences of data were calculated using the SPSS 23 package (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY) and results were presented as means ± standard deviations (SD). The normality of data was assessed using the Kolmogorov-Smirnov test. The 20-m sprint, vertical jump height, leg explosive power and anaerobic power data which confirming normality was analyzed by repeated-measures analysis of variance (ANOVA) with Bonferroni adjustment for time point comparisons. Mauchly’s test was used to assess the Sphericity assumption. While assumption was violated Greenhouse-Geisser correction was used for evaluation of Within-Subject effect. However, abnormally distributed VO_{2max} and COD data were analyzed with the Friedman test followed by Dunn’s pairwise post hoc test for comparing time points. Additionally, relative delta change (%) scores (first period, second period, seasonal changes) were analyzed. The paired t-test was used to evaluate the differences in sets, numbers, durations and scores between periods of the season. The test-retest reliability for the measurements demonstrated the intraclass correlation coefficient greater than 0.90 with an excellent agreement. Partial eta-square (η2) or Kendall's W is used to determine the effect size of the change between assessments. The values are classified for η2 as follows: η2<0.04, no effect; η2= 0.04–0.25, minimum effect; η2= 0.25–0.64, moderate effect; η2>0.64, strong effect (Ferguson, 2009) and for Kendall's W was interpreted as follows: 0 – 0.20 = very weak effect, 0.20 – 0.40 = weak effect, 0.40 – 0.60 = moderate effect, 0.60 – 0.80 = strong effect, 0.80 – 1.00 = very strong effect (Rovai, Baker & Ponton, 2014). The level of significance for all data was considered as p<0.05.

3. RESULTS

The statistical information of the volleyball matches played in the regional division throughout the season are depicted in Table 1, where there was no significant difference between the first and second periods for the sets, scores and durations. The physical performance variables of female volleyball players in the regional division in three separate stages (pre, mid, or ending) throughout the season are presented in Table 2.

Table 2. Physical performance variables of female volleyball players during the competitive season

n=43	**Pre-season** Means ±SD	**Mid-season** Means ±SD	**End of season** Means ±SD	**p**	**Effect size**
VO_{2max} (ml/kg/min)	37.9±1.1	39.7±1.5 [a]	40.3±1.4 [ab]	<0.001*	0.99
20m sprint (s)	4.25±0.3	4.15±0.3[a]	4.11±0.3[ab]	<0.001	0.88
Change of direction (s)	13.3±0.8	13.18±0.8[a]	13.09±0.7[ab]	<0.001*	0.99
Anaerobic power (watt)	329.9±42	351.1±50[a]	358.1±51[ab]	<0.001	0.94
Vertical jump height (cm)	37.5±4.8	38.8±4.6[a]	39.4±4.3[ab]	<0.001	0.90
Leg explosive power (watt)	1183.1±181	1236.5±194[a]	1282.5± 189[ab]	<0.001	0.82

** Friedman test was used, otherwise repeated measures ANOVA was performed*
[a] Statistically significant (p<0.05) when compared with Pre-season
[b] Statistically significant (p<0.05) when compared with Mid-season

It was observed a linear increase in all physical performance characteristics tested over the entire competition season. There was a significant difference between the three test sessions (Pre, mid, end of the season) for the VO_{2max} ($p<0.001$, Kendall's W=0.99 [very strong effect]), 20-m sprint ($p<0.001$, $\eta^2= 0.88$ [strong effect]), COD ($p<0.001$, Kendall's W=0.99 [very strong effect]), anaerobic power ($p<0.001$, $\eta^2= 0.94$ [strong effect]), vertical jump height ($p<0.001$, $\eta^2= 0.90$ [strong effect]) and leg explosive power ($p<0.001$, $\eta^2= 0.82$ [strong effect]) scores.

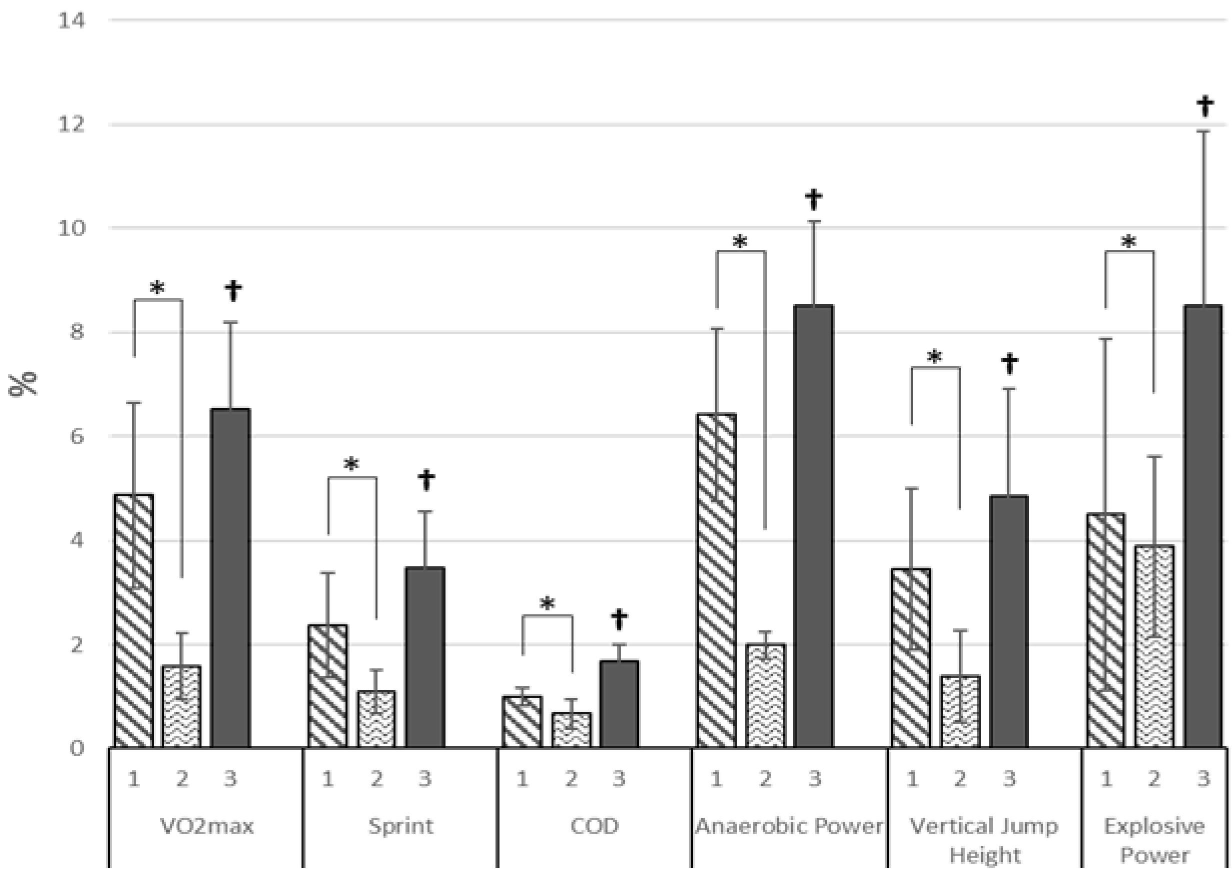

Figure 1. Percent of seasonal changes in physical performance characteristics

*1 = First period; 2 = Second period; 3 = Seasonal change; COD = Change of direction, † = Seasonal variations (p<0.05), * = Difference between periods (p<0.05).*

The relative delta change scores are shown in Figure 1. The prolonged competition season in the regional division induced a statistically significant improvement in VO_{2max} by 6.3%, in 20-m sprint time by 3.4%, COD ability by 1.6%, in vertical jump height, in explosive by 8%and anaerobic power by 8.3%($p<0.05$). In addition, though improvements in both the first and second periods of the season were significant, improvements in the first period were statistically higher than the second period for VO_{2max} (4.7 vs 1.5%, $p<0.05$), 20-m sprint (2.4 vs 0.98%, $p<0.05$), COD (0.9 vs 0.7%,

$p<0.05$), anaerobic power (6.6 vs 1.9%, $p<0.05$), vertical jump height (3.46 vs 1.54%, $p<0.05$), and explosive power (4.48 vs 3.72%, $p<0.05$).

4. DISCUSSION

This research was the first to examine, to our knowledge, the seasonal changes in the physical performance characteristics of female volleyball players throughout the competition season, covering a total of 16 weeks in the regional division. The findings of this study were that the VO_{2max}, sprint, COD, anaerobic power, vertical jump and explosive power abilities of female volleyball players improved significantly during both the first and second periods of the competition season. The findings also revealed that improvements in physical performance characteristics were significantly higher in the first period of the competition season compared to the second period.

This study demonstrated a significant improvement in VO_{2max} overall by 6.3% at the end of the season. This result is consistent with previous studies that reported improved aerobic performance of elite female (Purkhus et al. 2016) or male (Vilamitjana et al., 2006) volleyball players during the competition season. In addition, Karahan (2018) stated that the prolonged competition season has a significant impact on the improvement of the aerobic performance of semi-elite female volleyball players. However, Hakkinen (1993) and Manna et al. (2012) reported that there was no significant difference in VO_{2max} values of elite female volleyball players during the competition season. These differences in the literature data may be related to factors such as training patterns applied during the competition season, players' adaptation to training or competition levels. The present study also revealed a progressively significant improvement in VO_{2max} in both the first and second periods. However, the increase in the first period was substantially higher than in the second period of the competition season. Although volleyball game consists of short-term high-intensity intermittent repetitive movements that require phosphogen (ATP-CP) and glycolytic energy systems (Lidor & Ziv, 2010), the aerobic system is essential for replenishing muscle energy stores or recovery during the short rest intervals. (Tomlin and Wenger, 2001). For this reason, coaches often focus on high-intensity training methods for the development of anaerobic performance characteristics as well as technical-tactical studies during the competition season (Marques and Marinho 2009). Even though the development of aerobic capacity is under the influence of long-term and medium or high-intensity training protocols, short-term exercises with maximum intensity induce a significant increase in aerobic enzyme activities as well as the anaerobic enzymes (Rodas et al., 2000). Therefore, one explanation is that aerobic enzyme activities inducing the increase in VO_{2max} were likely to be more intense in the first period of the competition season compared to the second period.

Due to the technical and tactical tasks required by the individual positions on the court, players frequently have to perform multi-directional movements such as short sprinting, change of direction, acceleration and deceleration during volleyball games or its training season (Sheppard et al.2007). For this reason, the long-term competitive season induces the improvement of both sprint and change of direction abilities of the players (Lidor and Ziv, 2010). Concerning, Gabbett (2008) reported that skill-based conditioning training affects significantly improving both COD and sprinting ability of elite young female volleyball players during the competition season. However, COD and sprint performance improvement differ according to the athletic abilities of the players or their training schedule in the season (Fry et al., 1991; Purkhus, 2016). The present study resulted in a significant improvement in both COD (1.6%) and 20m sprint performance (3.4%) of female volleyball players in the regional competitive season. These results were in line with the previous study in which Karahan (2018) reported that semi-elite female volleyball players' COD (1.6%) and sprint (2.1%) performances improved significantly during the long-term competition season. The present study also indicated that the improvement in linear sprinting (first period=2.4%, second period= 0.9%) and COD (first period= 0.7%, second period= 0.98%) abilities in the first period of the competitive season was significantly better than in the second period. The slight improvement in the second period could be explained by the fact that players may be approaching their peak COD and sprint performances towards the end of the prolonged competitive season, therefore, making it difficult to improve their level any further (Clemente et al, 2020).

Attacks and blocks, which make up 45% of the total movements and 80% of scores in the volleyball game are performed with vertical jump movements based on the leg explosive power (Sheppard et al., 2009). For this reason, muscle strength and muscle power are the most important factors that provide advantages for successful participation in volleyball competitions as well as technical and tactical skills (Marques et al., 2008). The results obtained from female volleyball players show a significant increase in vertical jumping height (4.9%) and leg explosive power (8%) over the competitive season. The relatively significant increase in jumping height of players could perhaps have been attributed to a greater focus jump training in-season or be associated with the intensity of successful jump movements performed during competitions. These results were confirmed by Gonzale-rav et al. (2011), Moreno et al. (2018) and, Rousanoglou, Barzouka and Boudolos (2013) who explained that seasonal jumping training and successful jumping movements frequently performed in competitions contributed to the improvement of the vertical jump height and leg explosive power of elite female volleyball players. However, the current findings were not consistent with the results of Hakkinen (1993) and Nesser and Demchak (2007). They also stated that during the competition season, there would be no significant change in the vertical jumping height of elite female volleyball players who are already at high-performance levels. The vertical jump or the associated leg explosive power can be significantly improved by training protocols that include jumping, such as plyometric (Slimani et al, 2016). Regarding this, as a short-term strategy, a high-intensity training program with 180 to 250 jumps per session for two weeks (three times a week) is likely to achieve significant improvements in the explosive power of amateur athletes, especially. (Maćkala and Fostiak, 2015). Given that a player performs an average of 115 jumps in a volleyball match playing (Medeiros et al., 2014), it is likely that players' vertical jump and explosive power abilities will improve during a 16-week competition involving at least 54 training seasons. The current study also revealed that the vertical jump height and leg explosive power gradually increased significantly in both periods, but the increases in the first period (3.46%) were significantly higher than in the second period (1.54%). These results were supported by Stanganelli et al. (2008), who explained that the jump improvements mainly occurred more during the first period of the season. On the contrary, Newton et al. (2006) reported that in the first period of the competition, elite female volleyball players' vertical jump ability and power output significantly decreased. However, they suggested by resulting that ballistic resistance exercises applied in the last four-week period of the season compared to traditional training induced significant increases in vertical jumping height and power output. From this point, the possibility of plyometric and ballistic resistance training to be performed intensively by players throughout the season to improve vertical jump and explosive power could be an explanation. In addition, the lower jump and power output improvement observed in the second period may be due to the players approaching the limits of their maximum level for neuromuscular function, or reduced ballistic resistance training towards the end of the season (Stanganelli et al. 2008).

Anaerobic power refers to the efficient utilization and regeneration rate of musculoskeletal energy stores (ATP-PC and glycogen) during repeated high-intensity intermittent or sprinting actions with brief rest intervals. Anaerobic enzyme activities and the ability to resist fatigue, which has the potential to be improved mostly by high-intensity interval training, is considered to be an important indicator of anaerobic power (Sousa et al, 2017. In a top-level (division 1) volleyball game with an average of 44 rallies per set, the average rally lasts 7 seconds, mostly 12 seconds (76%) with 14 seconds rest breaks (Sheppard et al. 2009). Anaerobic power is one of the most important factors in influencing the performance in offensive and defensive maneuvers performed within these rallies. Consistently significant improvements (8.3%) in anaerobic power were observed throughout the regional volleyball competition season. This improvement is likely due to the impact of high or maximum intensity training performed in the competition season (Koral et al, 2018). Regarding this subject, Dupont et al. (2004) stated that anaerobic power tends to improve throughout the competition season following the specific training programme in male soccer players. However, Hakkinen (1993) and Karahan (2018) reported significant decreases in mean anaerobic power during the prolonged competition season for elite and semi-elite female volleyball players, respectively, while Pfeifer et al. (2017) remained unchanged. The contradiction of this result with the literature may be explained by the fact that less trained athletes have higher physiological responses to training for the increase in anaerobic enzyme activation compared to elite athletes with developed anaerobic power (Weston et al, 1997). In addition, the competitions in the subdivisions are mostly performed with less intensity and volume compared to elite levels (Palao et al, 2004). Therefore, athletes competing in subdivisions may have been less exposed to physiological and psychological stresses caused by high-intensity competitions that can negatively affect anaerobic power improvement (Haneishi et al, 2007). One explanation may be that the improvement in anaerobic power is associated with an increase in VO_{2max}, which induces an increase in the regeneration rate of musculoskeletal phosphagen stores for fast recovery during game breaks (Tomlin and Wenger, 2001). The anaerobic power values in the second period were significantly higher (1.9%) than the baseline, although the improvement tended to decrease compared to the first period (6.6%), ($p < 0.05$). This difference between periods in anaerobic power improvement may be an indication that the fatigue resistance ability of female volleyball players can decrease significantly towards the end of the competition season (Stone and Schilling, 2020).

The current study results showed that there could be significant improvements over the entire season (both from pre- to mid-season and from mid- to the end of the season) in all physical performance characteristics of female volleyball players competing in the regional division. These results are therefore important to suggest also that there could be significant functional improvements in the physical fitness of amateurs or players with low levels of competition. These improvements in physical performance characteristics may be associated with some factors such as insufficient or shorter preparation period, low competition intensity, training efficiency, and players' adaptation level to these training in-season. Although there was no significant difference between the periods of the season in terms of score, duration and number of sets, improvement in physical performance characteristics in the first period was higher than in the second period. These results may indicate that players' training and playing adaptations for improvement in physical performance characteristics could be higher in the first period of the season than in the second period.

In addition, towards the end of the competition season, as the final series approaches, it may be expected that the resulting fatigue associated with increased match load and stress will have a negative impact on the physical fitness (Koutedakis, 1995). However, the specific condition training applied in the second period (Newton et al., 2006) or the last weeks of the season (Purkhus et al., (2016) significantly affect the improvement of fitness characteristics such as strength, sprint and jumping performances. A possible explanation for the athletes participating in this study was that the volume of specific fitness training decreased against the increasing skill-based technical and tactical training volume towards the end of the competition season.

There were some limitations in this study that should be taken into consideration. Not to ignore data variability that may be affected by differences in the group such as match playing intensity and volume, players that from just one group of the six in the regional division of the official Turkish volleyball league were planned to include in this research. This study was also limited only to analysing the data for players who participated in at least 75% of both the competition and training season. Initially, 70 players selected in line with the coaches' predictions voluntarily participated in this study, but 43 players were able to complete the test protocols at the end of the competition season. Additionally, there was a lack of knowledge of training practices that would influence possible seasonal changes in physical performance due to the difficulty of monitoring the training season of each team during the competition season. Therefore, data collection might not be representative of all female volleyball players competing in the regional division. Further comprehensive studies with a large sample from different groups of the same division are needed to highlight a more holistic understanding of the physical performance changes of female volleyball players during the regional competition season. In conclusion, nevertheless, the results of this study may be important for optimizing seasonal training programs and providing normative and physical performance standards for female volleyball players competing in the regional league.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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