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EFFECTS OF BEACH VOLLEYBALL TRAINING ON PHYSICAL PERFORMANCE IN YOUNG INDOOR VOLLEYBALL PLAYERS

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(Original scientific paper)

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Abstract

The aim of the present study was to assess the effects of Beach Volleyball training program on physical performance in young indoor volleyball players. Fourteen young male volleyball athletes (16±2 years) consented to participate in program and lower-body power and agility testing. The participants performed the Attack, Block jump tests and Standing Broad jump test for lower-body power and Sprint 9-3-6-3-9 m and 10 x 4,5 m Lateral Shuffle Test for agility. One cycle of six weeks was analyzed in off-season (2014). Players were involved in specialized Beach Volleyball program and exercises were selected based on previous experience and according to performance analysis in beach volleyball studies. There were no significant differences ($p > 0.05$) between pretraining and posttraining for Block jump ($p=0,612$) and Spike jump ($p=0,525$). However, there was a significant ($p \leq 0.05$) improvement in agility tests. Training induced significant ($p \leq 0.05$) improvements in 9-3-6-3-9 agility test ($p=0,016$) and Side steps 10x4.5 m ($p=0,021$). The results of this study indicate that there were no significant improvements in jumping performance. However, agility test showed improvement in post testing compared to pre testing following a 6 week of beach volleyball training program. The differences in intensity of training, training volume and sample size could be a reason of the discrepancy in results compared to previous studies. However, this kind of study could provide practical application for coaches and sport researchers.

Key words: *volleyball, impact, sand, jumping ability, running*

Introduction

In recent years Beach volleyball has become very popular due to the fact that the 2008 FIVB Beach Volleyball World series consisted of 39 events (19 women's / 20 men's) with a total prize pool of approximately $8,300,000 (FIVB, 2008). Regarding the increased popularity and professionalism, there is a growing demand for a clearer understanding of the physical requirements. Beach volleyball is a very demanding sport which is played outdoors usually under difficult conditions such as high temperature, wind even rain. The number of matches played per day (2 up to 5) during the weekend tournament and the fact that both players touch the ball in almost every phase of the game are factors of extra difficulty. Furthermore, volleyball performance (jumps, dives and other sport-specific drills) on sand makes beach volleyball more demanding than indoor volleyball (Dimitrios, Vamvakoudis, Christoulas, Stefanidis, Dimosthenis, Papaevangelou, 2013). Similar to indoor volleyball, BV is a team sport characterized by its intermittent nature, fluctuating randomly from brief periods of maximal or near maximal activity to longer periods of moderate and low intensity activity (Arruda and Hespanhol, 2008; Magalhães et al., 2011). Clear understanding in this area could also contribute to improvements in training methods and provide targets for developing athletes. Beach volleyball players are forced to perform continuous actions under high temperatures and high humidity for many hours. In addition, moving on sand increases energy utilization compared to moving on solid ground (Zamparo, Perini, Orizio, Sacher, & Ferretti, 1992; Lejeune, Willems, & Heglund, 1998). Magalhães, Inácio, Oliveira, Ribeiro, Ascensão (2011) analyzed the physiological and neuromuscular impact of a one 3-set beach-volleyball match and the ability of the players to recover from fatigue. Match induced a temporary reduction in lower limb strength and sprinting time but 3h after the match all variables with the exception of the sprinting time, were recovered.

A large proportion of literature that has studied the performance analysis in beach volleyball has been increasing in recent years (Palao, Valades, Manzanares, and Ortega, 2014; Palao, Valades, and Ortega, 2012; Pérez-Turpin, Cortell-Tormo, Chinchilla-Mira, Cejuela-Anta, and Suárez-Llorca, 2008; Rocha, and Barbanti, 2007; Giatsis, and Papadopoulou, 2003; Giatsis, Zetou, and Tzetzis, 2005). The studies, performed in male games in the World Tour, showed that the players perform on average 100 jumps per set, and six jumps per rally (Pérez-Turpin et al., 2008). It has also been identified that the skill of blocking accounts for 27% of the total jumps within a game of beach volleyball (Giatsis, 2001). The higher an athlete can jump when performing a block jump, the greater potential for a reduction in effectiveness of the attacking opponent. In addition, Palao et al., (2014) showed that the blocker executes more jumps (33 jumps) than the defender specialist (28 jumps) per set. Regarding the fact that beach volleyball is a relatively new sport, its testing procedures have largely been adopted from the indoor game and are consequently performed on firm surfaces. It is likely that vertical jump height on sand is lower than on land due to a reduction in the ground reaction force. However, despite this, the strong correlation between land and sand scores suggests that vertical-jumping ability exists as a general quality and is not greatly influenced by test surface in the subjects tested. This suggests that land-based tests can be used to assess sand jumping ability in experienced beach volleyball players. (Bishop, 2003). Very little research exist regarding the beach volleyball training and its effects on performance. One study found that the physical training that beach volleyball players are subjected to during the annual cycle does not affect resisting levels but influences insulin, glucose, and visfatin concentrations, along with the markers of prooxidant/ antioxidant balance (Pilaczyńska-Szcześniak, et al, 2011). One more study examined the effect of systematic beach volleyball training and competition on running economy (RE) and VO2max of indoor volleyball players. Body mass and fat were significantly decreased after the beach volleyball period. Additionally, the results indicate a significant increase in VO2max ($p<.01$) both in absolute (L·min) and relative (ml·kg·min) values (Balasas, et al, 2013). Beside a very little research in Beach Volleyball, an important consideration regarding the influence of training on muscle performance is the nature of the training surface. Sand surface is associated with a greater degree of shock absorbance and lower stress to soft tissue and bones on the lower limbs (Barrett, Neal and Roberts, 1997). In addition, less muscle soreness is observed after similar plyometric activity on a sand surface compared to a firm, wooden surface (Miyama & Nosaka, 2004). Moreover, Impellizzeri et al. (2008) reported similar improvements in jumping and sprinting ability following four weeks of plyometric training on sand and grass surfaces. Mirzaei, et al. (2014) also examine the effects of six weeks of depth jump vs. countermovement jump training on sand on muscle soreness, jump, sprint, agility and leg press strength and found that training on sand can improve jumping and sprinting ability, agility and strength performance.

It is very common for indoor volleyball players to perform beach volleyball training during summer time and participate in official tournaments in order to keep in good physique, since 85 rallies occur in 25-42 minutes of play (Giatsis, 2003; Giatsis & Zetou 2003). In addition, the studies on beach volleyball involving the physical characteristics have been performed only in senior high performance competitions (Giatsis et al., 2005; Palao et al., 2012; Pérez-Turpin et al., 2008). It has been suggested that due to the innate differences in performance capabilities between young players and senior players, it would be inappropriate to apply physical demands of senior players to young players (Harley et al., 2010). Therefore, the aim of the present study was to assess the effects of Beach Volleyball training program on physical performance in young indoor volleyball players. It was hypothesised that young indoor volleyball players would be able to improve their physical performance following 6 week of beach volleyball training program.

Methods

Subjects

Fourteen young male volleyball athletes consented to participate in lower-body power and agility testing, and the procedures involved in the study were in accordance with and approved by institutional ethics. Descriptive characteristics are presented in Table 1. All the participants provided written consent after being informed of the test protocol. The protocol of the study was approved by the Ethical Committee of the Faculty of sport and physical education, University of Nis, and according to the revised Declaration of Helsinki. Each player had at least 4 years of training experience, corresponding to 2-hour training sessions, and at least 1 competition per week.

Table 1. Descriptive characteristics of the subjects*

Age (y)	Training experience (y)	Body height (cm)	Body weight (kg)	Standing reach height (cm)
16±2	5±1	1.84 ± 0.08	71±3	232±8.48

*Data are reported as mean ± SD.

Procedures

This study was designed to address the question of how beach volleyball training on sand affects jumping ability and agility gains, after a 6-week training program. Jumping ability and agility performance tests were performed before and after training. This design enabled us to examine the impact of sand surface on muscular performance. The initial tests were completed on one day as part of a regular testing program. Before the initiation of the training program subjects were instructed about the proper execution of all the exercises that were to be done during the training period. None of the subjects had performed any strength or jump training before. They were instructed to avoid any strenuous physical activity during the experiment and to maintain their dietary habits for the whole duration of the study.

The players underwent physical tests assessment in an indoor stadium. During the testing, the air temperature ranged from 22°C to 25°C. Testing began at 10 am and finished by 1 pm. None of the participants had been injured 6 months before the initial testing as well as during the training program. There was no supplement addition to the diet of the players. Measurements were taken on Monday morning because the athletes had rested during the weekend. The testing session began with anthropometric measurements. The players were then instructed to assess lower-body muscular power and agility tests. Up to 3 trials were given on each jump, with a 1-minute rest between jump test trials. The participants were all tested during the off- season. Typical practice warm-up was completed before the testing sessions. This warm-up included 10 minutes of general activity (walk, jog, light stretching), followed by 10 minutes of dynamic activity that increased in speed and intensity, followed by 3 to 5 minutes of rest before beginning the testing session. The players were encouraged to perform static stretching between trials. Body height and body weight were measured according to the instructions of the International Biological Program – IBP. Body height was measured with a GPM anthropometer (Siber & Hegner, Zurich, Switzerland) to the nearest 0.1cm. Body weight was obtained by TANITA BC 540 (TANITA Corp., Arlington Heights, IL) to the nearest 0.1kg.

Measures

Spike and block jump performances

For the standing reach, while wearing their normal volleyball footwear, players were requested to stand with their feet flat on the ground, extend their arm and hand, and mark the standing reach height while standing 90° to a wall. Players were encouraged to fully extend their dominant arm to displace the highest vane possible to determine their maximum standing reach height. The measurement of the standing reach height allowed for a calculation of the relative jump heights on each of the jumping tasks (absolute jump height (cm) – standing reach height (cm) = relative jump height) (Sheppard et al, 2009).

Spike (SJ) and block (BLJ) jump performances for volleyball players depend heavily on the height at which these skills are performed above the net and are determined by not only the capacity of the athlete to raise vertically his center of gravity, but also his stature and standing reach. In this particular case, specific tests would provide a further understanding of the training-induced adaptation. For the SJ, the standing reach was determined as the maximal distance between the fingertip of the attack hand and the ground, while standing 90° to a wall. The SJ was measured from a running lead (2- or 3-step approach) by using a basketball backboard marked with lines 1 cm apart with a 1-minute rest interval between them (Hasegawa, Dziados, Newton, Fry, Kraemer, and Hakkinen, 2002). For the BLJ, the standing reach was determined as the maximal distance between fingertips of the block hands and the ground, while facing the wall. The BLJ jumps started from a standing position with the hands at shoulder level and arms raised from the start position without extra swing. All tests used the same observer who was situated on a volleyball referee stand placed 2 m from the backboard. Both jumps were recorded as the best of the 3 attempts (Stanganelli, Dourado, Oncken, Mançan, da Costa, 2008).

The standing broad jump was used for assessing the explosive power of the lower limbs. The players were instructed to stand behind a line and jump as far as possible—allowing arm and leg countermovement. The distance was measured from behind the line to the back of the heels at landing. The intraclass correlation coefficient for test-retest reliability and for the SBJ test was 0.97, respectively.

Agility tests

Sprint 9-3-6-3-9 m. The players started after the signal and ran 9m from starting line to the first line (the lines were white, 3 m long, and 5 cm wide). Having touched the line with one foot, they made either an 180 left or right turn. All the following turns had to be made in the same direction. The players then ran 3 m to second line, made another 180 turn, and ran 6 m forward. Then, they made another 180 turn and ran another 3m forward, before making the final turn and running the final 9 m to the finish line. The intraclass correlation coefficient for test-retest reliability and for the SBJ test was 0.94, respectively.

10 x 4,5 m Lateral Shuffle Test. The Edgren Side-Step Test has used solely shuffling movements (Chu, Shiner, 2006; Harman, Pandorf, 2000; Tomchuk, 2011) and is a prominent field test. However, some tests differed from the original test and have reported their own versions (Chu, Shiner, 2006; Tomchuk, 2011.). It appears to be no consistent procedures for the ESST. The lateral shuffle test in this study was modified and ESST was chosen because it is the only test consisting entirely of lateral movements (Brughelli, Cronin, Levin, Chaouachi, 2008). The Lateral shuffle test used a 4,5 m distance with lines marked on both sides. The participants started the test straddling one of the lines. They moved laterally and crossed the last line before changing directions. The participants shuffled continuously for ten times. Participants were instructed not to cross their feet during the duration of the test, and a trial was discarded if a participant crossed his or her feet. The intraclass correlation coefficient for test-retest reliability and for the SBJ test was 0.96, respectively.

Training program

One cycle of six weeks was analyzed in off-season (2014). The schedule of the performed off-season beach volleyball training is shown in Table 2. The goals of the off-season conditioning were to increase the intensity of sport-specific training, and attention was given to volleyball skills and movement in sand. One week before the training program players performed the general conditioning in order to level the conditioning of players after the break. None of the players was performing any additional resistance or aerobic training outside of the 3 beach volleyball training sessions. The duration of training sessions was recorded, with sessions typically lasting 90 min. For this purpose beach volleyball exercise were selected based on previous experience and according to performance analysis in beach volleyball studies in order to set proper exercise intensity responses of traditional drills is suggested by previous authors. After warm up, in the first part of sessions players were involved in technical drills and after that they were divided in smaller groups (3 vs. 3) practising on smaller courts. In the end, players played a 2 vs. 2 games, with constant changes where the winning team would always stay on the court. Although the duration of each individual rally in this drills was not controlled by the coach, total duration of the drill can be recorded to assist in inter and intra-session planning.

Table 2. Training sessions of Beach volleyball training program

Goal: Off-season beach volleyball program	
Sessions 1–18 (Monday-Wednesday-Friday)	
Exercises	
Warm up	General activity + specific warm up with the ball (25 min)
Instructional drills for technique	20 min of drills that include low intensity movement and combine beach volleyball technique. Two drills were performed with 2 minute break between.
3 vs. 3, 2 vs. 2	Small-sided (3 vs. 3) games where the volleyball court was separated in two smaller (9 x 4.5 m) courts. Competition drills (2 vs. 2) with the majority of free balls to each side thrown by the coach. Teams rotate depending of the scoring. After one team reaches 15 points players take two minute break (40 min).
Stretching	5 minutes of stretching for the muscle groups mainly involved in sessions

Statistical Analyses
Data analysis was performed using the Statistical Package for Social Sciences (v13.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics were calculated for all the experimental data. In addition, the Kolmogorov–Smirnov test of the normality of distribution was calculated for all variables before the analysis. Changes in the anthropometric characteristics, lower-body muscular power and agility of players over the training period were compared using t-tests. The level of significance was set at $p \leq 0.05$ and all data are reported as means ± SE.

Results
Lower-body muscular power
The changes in Block jump, Spike jump and Standing broad jump are shown in Table 3. There were no significant differences ($p > 0.05$) between pretraining and posttraining for Block jump (p=0,612) and Spike jump (p=0,525). However, there was a significant ($p \leq 0.05$) improvement in Standing broad jump.

Table 3. Lower-body muscular power and agility of young volleyball players before and after 6 weeks of training

	initial	final	P value
Block jump	48,36 ±3,795	48,64 ±4,031	0,612
Spike jump	58,29 ±4,890	58,57 ±5,019	0,525
Standing broad jump	211,93± 1,93	215,21± 0,83	0,009*
9-3-6-3-9 agility test	7.95±0.49	7.38±0.52	0.016*
10 x 4,5 m Lateral Shuffle Test	15,20 ± 1,09	14,30 ± 0,93	0,021*

* Significant difference $p < 0.05$ between initial and final testing

Agility
Compared with pretraining, there was a significant ($p \leq 0.05$) improvement in agility tests (Table 3). Training induced significant ($p \leq 0.05$) improvements in 9-3-6-3-9 agility test (p=0,016) and Side steps 10x4.5 m (p=0,021).

Discussion
This study investigated the effect of a beach volleyball training program on the measurements of physical fitness in young male indoor volleyball players. A significant improvement in agility was observed. However, there were no significant differences between pretraining and posttraining for lower-body muscular power.

In our study, results for Block jump and Spike jump test showed there were no significant difference between groups pre- to post-training ($p > 0.05$). Our findings are in contrast with those of, Gehri et al. (1998) and Thomas et al. (2009) who reported significant improvement in jump height after 12 and six weeks of Drop jump and Counter movement jump training on solid surface with no differences between them. According to previous authors suggestions the longer contact time can induce the less effective the Stretch shortening cycle (Saez-Saez De Villarreal, Kellis, Kraemer, Izquierdo, 2009). During performing plyometrics on sand, compliance and friction can plays negative effects on SSC, decreases of myotatic reflex, degration of elastic energy potentiating and increase amortization phase resulting worsens in performance (Impellizzeri, Rampinini, Castagna, Martino, Fiorini, Wisloff, 2008; Miyama, Nosaka, 2004; Giatsis, Kollias, Panoutsakopoulos, Papaiakovou, 2004). The role of the Stretch shortening cycle in jump performance appears to be lower for beach volleyball than other team sports, however it is still an important component of performance. The importance of players having a high power to weight ratio is evident and should be carefully considered when designing and monitoring elite beach volleyball athlete training programs (Riggs & Sheppard, 2009).

Several authors have reported significant improvements in Vertical jump, countermovement jump and Standing broad jump using jumping training in sand [Chu, 1998; Asadi, 2012; Markovic, Jukic, Milanovic, Metikos, 2007; Young, Bilby, 1993). However, there is still a discrepancy about the factors influencing these improvements. Many researchers suggested that gains after plyometric training are attributed to a neural adaptation located in the nervous system rather than to morphologic changes (Maffiuletti,Dugnani, Folz, Di Pierno, Mauro, 2002; Canavan, Garrett, Armstrong, 1996; Markovic, Mikulic, 2010; Potteiger, et al., 1999).

Significant improvements were found in agility tests. These findings are in line with the previous authors who reported significant decreases in time during agility tests following training (Thomaset al. 2009; Miller, et al., 2006; Mirzaei, B. et al., 2014; Gortsila, Theos, Nesic, *Maridaki* ,2013). Thomas et al. (2009) compared the effects of six weeks of Drop jump and Countermovement jump training on agility (505 agility test) in young soccer players and found that plyometric training could positively affect agility performance, with no significant differences between the modes. Agility improvement requires rapid force development and high power output, and it seems that Drop jump and Countermovement jump training on sand can improve responses to these requirements (Thomas, et al., 2009). Moreover, agility tasks require a rapid switch from eccentric to concentric muscle action in the leg extensor muscles (the SSC muscle function). Gortsila, Theos, Nesic, Maridaki (2013) showed in their study that training on sand surface could be a useful and effective tool for improving agility in prepubescent female volleyball players. Agility was significantly improved in both groups after the 10-week training program. The instability of the sand surface could be one of the explanation which contributed to the improvements of balance, which in turn improved agility. Moreover, when sprinting and jumping on the sand, arms can contribute more to performance result and therefore training on the sand could enhance strength improvements.

Conclusion

The results of this study indicate that there were no significant improvements in jumping performance. However, agility test showed improvement in post testing compared to pre testing following a 6 week of beach volleyball training program. It cannot be concluded that young volleyball players develop distinctive performance characteristics at this age and level. Therefore, more studies must be conducted in order to better understand the training on sand and its effects in indoor volleyball players. Sand surfaces can offer a higher energy cost and lower impact training stimulus compared with firmer and more traditional team sport training venues such as grass. However, during training on sand, compliance can play negative effects on stretch-shortening cycle, decreases of myotatic reflex, degration of elastic energy potentiating and increase amortization phase resulting in lower jumping performance. According to previous research and our results, clear conclusion about the effects of training in sand could not be given. The differences in intensity of training, training volume and sample size could be a reason of the discrepancy in results. However, this kind of study could provide practical application for coaches and sport researchers.

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