ORIGINAL ARTICLE

Small-sided games are more effective than instructional training for improving vertical jump performance and passing in young volleyball players

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Abstract

The aim of our research was to determine the effects of small-sided games on explosive strength in young volleyball players. The authors hypothesized that this program might significantly improve explosive strength in adolescent volleyball players.

Thirty-eight adolescent volleyball players participated in this study (12.26±1.01). They were tested for lower body explosive power and passing accuracy. Players were randomly allocated into a small-sided games group (n = 20) and instructional training group (n = 18). Each player participated in a 12-week training program that included 3 organized court training sessions per week.

Both groups made significant increases in block jump ($p < 0.05$) after 12 weeks of training, with significant interaction effect between the groups. There were no significant interaction effects between the groups ($p>0.05$) for spike jump. In SJ and CMJ results revealed a statistically significant difference between groups pre- to post- training ($p < 0.05$). Both groups made significant increases in passing accuracy with significant interaction effect between the groups.

Small-sided games appears to be an effective way of improving explosive power and passing skills in young volleyball players. The results of this study indicate that game-based training method was more effective for lower body explosive power than traditional instructional programme.

Keywords game-based • conditioning • impact • power • technique.

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Introduction

In recent years, an approach called game-based training has been developed in order to combine the skill and conditioning elements in a coordinated approach (Gabbett, 2003; Gabbett, 2002; Gamble, 2004; Nurmekivi et al., 2002; Sassi, Reilly, & Impellizzeri, 2005). Young players often find it hard to support the traditional fitness training, because of a lack of enjoyment and experience with this type of exercise (Wall & Côté, 2007). Therefore, the use of small-sided games as training drills offers the simulation of movement patterns in team sports, while maintaining a competitive environment in which athletes must perform under pressure and fatigue (Gabbett, 2002). Moreover, the important consideration is the optimization of skill development in team sport while still obtaining appropriate conditioning levels. Simply put, according to Magill (2007), transfer of practice to the game environment depends on the extent to which practice or training resembles the game. Moreover, small-sided games as a training method are very popular because it replicates the technical skills and decision making, whilst also representing the competitive match physiological demands (Sheppard, Gabbett, & Stanganelli, 2009). According to Sampaio et al, (2009) decrease in space and number of players in game allow greater intensity in game. In addition, Rampinini et al. (2007) confirmed aforementioned statement that the intensity of sided games increases while the number of players decreases.

Hill-Haas et al. (2008) stated that several studies showed the physiological impact of small-sided games on diverse team sports. However, studies that have assessed the specificity of small-sided games in volleyball are limited. Gabbet (2008) showed that skill-based conditioning games that simulate the physiological demands of competition in junior elite volleyball players offer a specific training stimulus. Gabbett, Georgieff, Anderson, Cotton, Savovic, and Nicholson (2006) have concluded that skill-based volleyball training improves speed and agility performance, spiking, setting, passing accuracy, spiking and passing technique, but has little effect on the physiological and anthropometric characteristics of players. They also stated that skill-based training programs should be supplemented with an appropriate amount of energy system training to enhance the physiological and anthropometric characteristics of talented junior volleyball players. Recently, Trajković, Milanović, Sporis, Milić and Stanković (2012) examined the effects of pre-season skill-based conditioning training in semi-professional volleyball players. The aforementioned authors stated that selected program does not offer a sufficient stimulus for semi- professional volleyball players due to the fact that there were no significant differences between pretraining and posttraining for lower-body muscular power (vertical-jump height, spike-jump height, and Standing broad jump) and agility.

Having in mind that volleyball has some unique skills, novice players find it difficult to master it due to small amount of transfer from other sports, except for footwork. Therefore, children require a great deal of repetition before they are able to consistently execute the fundamental skills. However, volleyball is often taught to children with little opportunity for skill practice, no lead-up games, and with full-sided teams. The advantages of small sided games are reduced number of players which equals a higher number of ball contacts and more quality decisions during the game. Moreover, players become more physically efficient in the smaller area, with more opportunities to lean tactical skills. However, the most important is that children may benefit from this fun and dynamic approach to learning the game of volleyball (Valentine, Madić, & Sporiš, 2017).

In addition to physical characteristics and technical skills in volleyball, the tactics and decision-making abilities are crucial in order to become a successful player (Broek, Boen, Claessens, Feys, & Ceux, 2011). However, the remaining challenge regarding the long-term athlete development is the amount of time devoted to various skills (Chevrier, Roy, Turcotte, Culver, & Cybulski, 2016). Therefore, more research is needed in order to confirm this theory, especially in younger volleyball players. The aim of our research is to determine the effects of small-sided games training on explosive strength and passing accuracy in young volleyball players. The authors hypothesized that this program might significantly improve explosive strength and passing accuracy in young volleyball players compared to instructional training.

Method

Thirty-eight youth male volleyball players participated in this study. The two participants in instructional training group didn't complete the program. Descriptive characteristics are presented in Table 1. Inclusion criteria were regular participation in practice sessions and competitions, and the absence of injury in the past 6 months. Prior to the start of the study, subjects undertook several tests to determine their baseline physical fitness and technical skill levels. Players were then randomly allocated into a small-sided games group (n = 20) or control group (n = 18). All subjects received a clear explanation of the study, including the risks and benefits of participation, and written parental or guardian consent was obtained before players were permitted to participate. The protocol of the study was approved by the Ethical Committee of the Faculty of Sport and Physical Education, University of Novi Sad, and according to the revised Declaration of Helsinki.

Table 1. Descriptive characteristics for the small-sided game (SSG) group and the instructional training group (ITG)

SSG	ITG
N = 20	N = 18
Age: 12.36±1.03 years	Age: 12.16±0.98 years
Pubic hair tanner stage: 3.4±1.1	Pubic hair tanner stage: 3.4 ±1.1
Genital tanner stage: 3.5±1.0	Genital tanner stage: 3.5±1.1
Height: 164.18±8.62cm	Height: 160.13±5.46 cm
Body mass: 48.99±10.79 kg	Body mass: 47.14±10.97 kg
Training experience: 2.4 ± 1.1 years	Training experience: 2.2 ± 1.3 years

Beside esults, basic anthropometric parameters (body height and body weight) were registered in the study protocol. Maturity was determined by self-assessment of Tanner stage (Weeks & Beck, 2010). The initial testing took place after the pre-season conditioning period while the final testing was performed after 12 weeks of intervention with the small-sided games training method and traditional instructional training. Both teams had comparable training loads and followed similar periodization throughout the season. At the time of the study, subjects were having 3 volleyball practice sessions and 1 match weekly, with no additional strength and conditioning training. All study procedures took place at a school athletic facility. All participants took part in one introductory week during which time proper form and technique on each fitness test were reviewed and practiced. During this session research assistants demonstrated proper testing procedures and participants practiced each test. Participants were asked not to perform any vigorous physical activity the day before or the day of any study procedure. Moreover, all participants were instructed to have a good night's sleep (≥ 8 hours) before each testing day, to avoid drinking, or eating at least 2–3 hours before testing. Also, the participants were motivated to give their maximum effort during performance measurements. The same researchers tested the same participants and the fitness tests were performed in the same order with identical equipment, positioning, and technique. Before each testing, the participants performed a standard 20-minute warm-up. Standard warm up protocol consisted of 10 min of warm up running and 10 min of dynamic stretching and 5 x 30m of running exercises.

Passing. The passing ability of the players was evaluated by determining their ability to return a pass to a target positioned at the net, 2 m from the right-hand sideline. The target dimensions were 1.6 m long and 2.3 m wide. A coach, positioned in the service position, approximately 1 m above the ground and 10 m from the receiving player, threw an overhead pass to the receiving player. Players were required to pass (dig) the ball to another player standing with arms extended above their head, in the target area. Players were awarded 2, 1 and 0 points if a pass did not reach either of the target areas. The aggregate from 6 trials was recorded as the player's accuracy score. More detailed explanation of the test could be found in Gabbett and Georgieff (2006).

Serving. Players were asked to hit 10 consecutive serves to designated areas in the opposite court. Players could choose their preferred position behind the service line. Serves were performed individually, and each serve was supplied to the server by another player. Players were allowed 8 seconds to hit each serve. The points for each serve were allotted according to the designated areas.

Service accuracy immediately after physical exertion. Players were allowed 5 sets of 2 consecutive serves (for a total of 10 serves) in which to hit to the designated areas on the opposite court. Each 2- serve set was performed following an effort designed to elevate the heart rate (HR). The physical exertion consisted of a block at the net, followed by a dig at the 3-m line, both performed twice, and again a block at the net. The players performed a block, dig, block, dig, and block. The HR of the players was measured (using Polar M31; Polar Electro Oy, Vantaa, Finland) immediately after completion of the physical exertion. Players could choose their preferred position behind the service line, but it had to be identical to the position at which they hit the serves at the rested condition. Serves were performed individually, and the ball for each serve was supplied to the player by another player. Players were allowed 8 seconds to hit each serve (16 seconds for each set). The points for each serve were allotted according to the designated areas. More detailed explanation for both tests could be found in Lidor, Arnon, Hershko, Maayan, and Falk (2007).

Countermovement and squat jump performance. For the purpose of the explosive strength assessing, a device “Myotest” was used. Subjects performed two vertical jumps, Countermovement Jump (CMJ) and Squat jump (SJ). The sample of the variables, processed and mistreated by the device “Myotest” consisted of the: Height (expressed in cm); Power (expressed in W/kg); Force (expressed in N/kg) and Velocity (expressed in cm/s). Subjects carried a belt around their lower trunk, on which was positioned a wireless device “Myotest” (safely attached to a belt). All subjects performed three vertical jumps (CMJ), in the following way: from the initial position, i.e., normal standing position and the hands placed on the hips, through the flexion in the articulations of the knee up to 90º, after the audio signal of the device, the subjects performed the maximum vertical take-off, and landed with affable flexion (up to 110º) in the articulations of the knee and finally, went back into a starting standing position, while waiting for the new sound signal, when the specified jump technique was repeated. In the case, when the CMJ was not well performed, double audio signal, informed the subject, to repeat properly specified jumping technique. At the end of the protocol, software of the device “Myotest”, automatically processed and mistreated the mean values of analyzed variables.

The squat jump (SJ) allows measurement of “non-plyometric” displacement and the ability to develop a great deal of strength within a very short space of time (explosiveness). This test consisted of the person jumping as high as possible with their hands on their hips from a half-squat position (i.e. 90° bending of the knees). This position was maintained for about 1s. The subjects were then instructed to extend the lower limbs as explosively as possible with the aim of performing a squat jump. Three attempts were made at this exercise. The best result was retained for analysis.

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 and block 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 spike jump, 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 spike jump 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 et al., 2002). For the block jump, the standing reach was determined as the maximal distance between fingertips of the block hands and the ground, while facing the wall. The block 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).

Training program

One cycle of 12 weeks was analyzed in the beginning of the season (2014/15). SSG and instructional training interventions were performed in the beginning of the season and added to the volleyball practice sessions three times a week for a total duration of 12 weeks. SSG and IT were always performed at the middle of a session, after a standardized warm-up, and matched for exercise duration. In the first part of sessions players were involved in low intensity technical drills and after that, SSG and IT were used. Two weeks before the training program players performed the general conditioning in order to level the conditioning of players after the break during off season. During the 12-week follow-up, the team played 4 friendly tournament matches. The goals of the small-sided games program were to increase the intensity of sport-specific training, and attention was given to volleyball skills and play. In addition, players were introduced with small-sided games rules. None of the players was performing any additional resistance or aerobic training outside of the 3 training sessions. The duration of training sessions was recorded, with sessions typically lasting 80-100 min. For this purpose, small-sided games exercise was selected based on previous experience and pilot studies in which mean exercise intensity is suggested by previous authors (Gabbett et al., 2006; Gabbett, 2008). The type of SSG used was 2v2 (7m x 3m) and 3v3 (12m x 6m) on smaller court. This configuration was chosen because of the greater intensity experienced in this type of drill compared to SSG involving more players (Sampaio et al., 2009). Another reason for using smaller court is because more players can exercise simultaneously (up to 12 players performing 3v3 drills at the same time). Drills were played like a competition. Although the duration of each individual rally in these drills was not controlled by the coach, total duration of the drill can be recorded to assist in inter and intra-session planning. The total repetitions can be easily quantified by summing the total points played in the rally, then multiplying by the number of rallies per point (Sheppard et al., 2009). The coach creates an emotionally intense environment by implementing a scoring system (e.g., team that wins 2 out of the 3 rallies scores one big point, 5 seconds rest) and by encouraging the players.

Control group was involved in traditional instructional training sessions. All skills were taught by using blocked practice, so that all trials for each skill were completed before moving onto the next skill (Gabbett, 2008). A typical training session consisted of players performing individual skills against a wall or to a partner in a noncompetitive environment, multiple repetitions, and practice of technique in a closed-skill environment.

Statistical analysis included descriptive analyses (means and standard deviations for the sample as a whole, and separately for the SSG and CG) for the pre- and post-training status. Normality and homoscedasticity assumptions for all data before and after intervention were checked respectively with Shapiro-Wilk and Levene’s tests. Training effects were analyzed using a two-way analysis of variance (ANOVA) (2 x 2) with repeated measures. Factors included training groups (SSG and CG) and time (pre- and post-training). When a significant F ratio was found, Tukey post hoc tests were used for pairwise comparisons. ES was classified as follows: <0.2 was defined as trivial; 0.2–0.6 was defined as small; 0.6–1.2 was defined as moderate; 1.2–2.0 was defined as large; >2.0 was defined as very large; and >4.0 was defined as extremely large (Hopkins, Marshall, Batterham, & Hanin, 2009). A criterion α level of P<0.05 was used to determine statistical significance.

Results

The Shapiro-Wilk test has shown that all data was normally distributed. The repeated measures ANOVA revealed a statistically significant difference between groups pre- to post-training (p<0.01) in Block jump. Pre- and post- treatment means and SD for Spike jump are presented in Table 2. Both groups made significant increases in Spike jump (p<0.05) after 12 weeks of training. However, there were no significant interaction effects between the groups (p>0.05).

In SJ and CMJ ANOVA revealed a statistically significant difference between groups pre- to post-training (p<0.01). SSG group experienced significant increase in both, CMJ and SJ pre- to post-testing, whereas CG group had no significant changes in the same period (Table 2).

Table 2. Jumping performance at pre- and post-training

Variable	SSG group (N=20)				CG group (N=18)			
	pre (Mean±SD)	post (Mean±SD)	Δ(%)	ES	pre (Mean±SD)	post (Mean±SD)	Δ(%)	ES
Block jump	34.10±7.48	35.33±5.67*†	3.6%	0.18	41.02±6.33	40.42±6.68	-1.5%	-0.09
Spike jump	46.63±8.70	48.63±8.72*	4.3%	0.23	43.73±7.30	47.26±8.66*	8.1%	0.44
SJ	20.29±4.65	22.21±3.91*†	9.5%	0.45	21.59±4.19	21.30± 4.74	-1.3%	-0.06
CMJ	26.16±6.59	30.87±5.62*†	18.0%	0.77	26.04±4.86	26.66± 4.84	2.4%	0.13

Legend: SSG small-sided games group; CG control group; pre pre-testing; post post-testing; Δ(%) percentage of change from pre- to post-testing; ES effect size for within-subjects factor; * Significant difference p<0.05 between pre and post training testing; † Significantly greater improvement than in CG group (p<0.05)

The changes in passing accuracy are shown in Figure 1. Small-sided games training induced significant improvements (p<0.01) in overhand pass (%diff=32.6%). There were no significant changes for forearm pass (p=0.3). Control group showed improvements in overhand passing also. However, in comparison to the control group, the improvements in overhand passing were greater (p<0.05) in the small-sided games group.

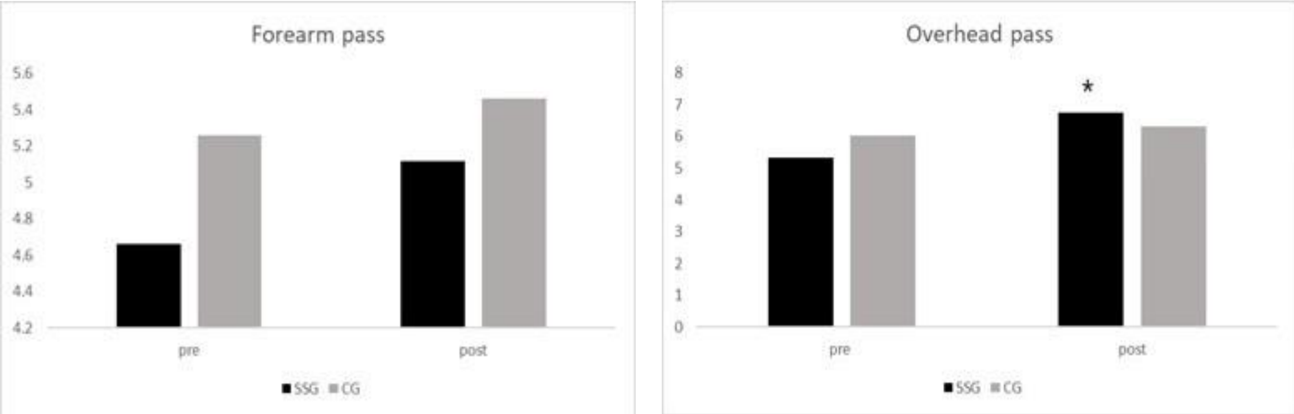

Figure 1. Changes in forearm and overhead passing at pre- and post-training. Values are means. * significantly different from pretraining (p<0.05).

Small sided games training induced significant improvements in serving (p=0.02) and serving under physical exertion (p=0.04). Control group showed improvement only for serving accuracy (Figure 2).

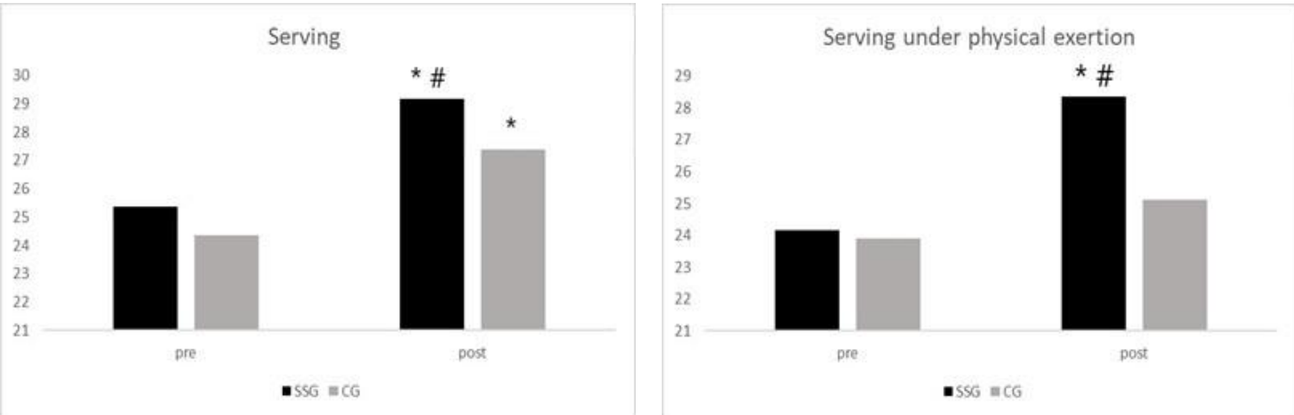

Figure 2. Changes in serving and serving under physical exertion at pre- and post-training. Values are means. * significantly different from pretraining; # significantly different from CG group (p<0.05).

Discussion

The present study investigated the effect of a small-sided games training program on passing and service accuracy and lower body explosive power in young volleyball players. Due to the different responses inherent with specific small-sided games volleyball training and traditional training, we hypothesized that the small-sided games volleyball training would be more efficient at enhancing skill accuracy and jumping performance.

After 12 weeks of small-sided games training, there were increases in overhand passing, serving and serving under physical exertion. The improved passing skills in response to training may reflect the highly repetitive nature of selected volleyball skills (e.g., serve receive, passing). However, it is interesting that SSG group showed better results compared to CG group having in mind that almost all traditional instructional training sessions were designed to develop volleyball technique and accuracy. We can speculate that children benefit more from this fun and dynamic approach during SSG. In similar study conducted on basketball players, two 4-week training programmes consisting of SSG or mixed training both resulted in improvements in various technical skills ranging from 17 to 27 % (Bogdanis, Ziagos, Anastasiadis, & Maridaki, 2007). This is consistent with Delextrat et al, (2014) who showed a significantly better improvement in shooting skills after SSG than HIT, while passing skills were similarly increased by both training methods. However, Krističević, Madić, and Krakan (2016) found that game-based training has similar effects with instructional training in improving skill accuracy in junior volleyball players. Additionally, Gabbett, et al (2006) found in volleyball that skill-based training improves spiking, setting, passing accuracy, spiking and passing technique. Our results show a tendency for better improvement in passing skills in the group undertaking SSG training. Possible explanation could be found in the fact that players in the SSG training always had a target during games, which is similar to the target during the passing tests. Moreover, short shuffling moves in SSG, associated with tests, which involve leg coordination in addition to passing ability could significantly contribute to better results.

Our results show that SSG training was more effective at increasing most performance parameters in young volleyball players compared to traditional instructional training and suggest that SSG training should be used preferentially due to their higher quantity of game-based specificity. Significant improvement was observed in all jumping tests for training group. However, there were no significant interaction effects between the groups for Spike jump, with both groups showed significant improvements. In similar studies with young male subjects Gabbett (2008) stated that skill-based conditioning games have induced improvements in speed, vertical jump, spike jump, agility, upper-body muscular power, and estimated maximal aerobic power. In addition, Gabbett et al. (2006) have concluded that skill-based volleyball training improves speed and agility performance, spiking, setting, passing accuracy, spiking and passing technique, but has little effect on the physiological and anthropometric characteristics of players. One recent study showed that skill-based conditioning training appears to have stronger effects in improving change of direction speed compared to lover body power in young female volleyball players (Krističević, Sporiš, Trajković, Penčić, & Ignjatović, 2016). Our results are also in opposition to another longitudinal 6-week study conducted in senior semi-professional volleyball players that showed no impact of skill-based conditioning training on jumping performance (Trajkovic et al., 2012). It is possible that training backgrounds of the players, training modality and exercise intensity prescription might explain discrepancies in these results.

Both groups showed significant improvement in spike jump. This is not surprising, since both training programs use the same technique to improve volleyball skills. Based on previous research, it was suggested that the training-induced adaptations in this type of specific tests (Spike jump test) could occurred due to the characteristics of the loads applied. Moreover, the drills (i.e., service, attack, and block) and matches during training programs have contributed significantly to the improvement of the performance in such a specific type of test (Stanganelli et al., 2008 Mancan, and da Costa, 2008).

Ziv and Lidor (2010) concluded that most recent studies in volleyball involve the effects on squat jump and countermovement jump showing that plyometric training should be included in volleyball training. In our study, results for SJ and CMJ test showed a statistically significant difference between groups pre- to post-training ($p<0.05$). In volleyball, a squat and countermovement jump are usually performed in a fast spike and in a static block jump (BJ). Volleyball players use two different BJ techniques, starting from an upright position or starting from a squat position, with a countermovement being performed in both cases (Amasay, 2008). Therefore, improvement in SJ and CMJ following small-sided games training was logical.

Studies of the effect of volleyball and physical conditioning training on the physiological characteristics of players could not show clear conclusions, with reports of increased (Fardy, Hritz, & Hellerstein, 1976; Franks & Moore, 1969; Hascelik, Basgöze, Türker, Narman, & Ozker, 1989), decreased (Häkkinen, 1993), or unchanged fitness (Gabbett et al., 2006; Trajkovic et al., 2012) in response to training. Therefore, more research is necessary in order to further examine the effects of different training programs in volleyball, especially game-based conditioning and its effects in volleyball.

Small-sided games appears to be an effective way of improving passing and serving accuracy and explosive power in young volleyball players. The results of this study indicate that this method was more effective for lower body explosive power than traditional instructional programme. From a practical viewpoint, these findings demonstrate that instructional-based training programs could be supplemented with small-sided games training or with appropriate amount of energy system training to enhance the physiological characteristics of young volleyball players. For proper volleyball conditioning and skill improvement, coaches could make training more specific in such a way that the transfer of training effects to game efficiency will be faster. Many coaches do not use the approach described in this article to the training process because they fear that the level of skills could decrease in young volleyball players.

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