

# THE EFFECTS OF 6 WEEKS OF PRESEASON SKILL-BASED CONDITIONING ON PHYSICAL PERFORMANCE IN MALE VOLLEYBALL PLAYERS

NEBOJŠA TRAJKOVIĆ,<sup>1</sup> ZORAN MILANOVIĆ,<sup>1</sup> GORAN SPORIS,<sup>2</sup> VLADAN MILIĆ,<sup>3</sup> AND RATKO STANKOVIĆ<sup>1</sup>

<sup>1</sup>Department of Sport and Physical Education, University of Niš, Niš, Serbia; <sup>2</sup>Department of General and Applied Kinesiology, University of Zagreb, Zagreb, Croatia; and <sup>3</sup>Department for Bio-chemical and Medical Sciences, University of Novi Pazar, Novi Pazar, Serbia

## ABSTRACT

Trajković, N, Milanović, Z, Sporis, G, Milić, V, and Stanković, R. The effects of 6 weeks of preseason skill-based conditioning on physical performance in male volleyball players. *J Strength Cond Res* 26(6): 1475–1480, 2012—The purpose of this study was to determine the changes in physical performance after a 6-week skill-based conditioning training program in male competitive volleyball players. Sixteen male volleyball players (mean  $\pm$  SD: age 22.3  $\pm$  3.7 years, body height 190.7  $\pm$  4.2 cm, and body mass 78.4  $\pm$  4.5 kg) participated in this study. The players were tested for sprinting (5- and 10-m sprint), agility, and jumping performance (the vertical-jump test, the spike-jump test, and the standing broad jump [SBJ]). Compared with pretraining, there was a significant improvement in the 5- and 10-m speed. There were no significant differences between pretraining and posttraining for lower-body muscular power (vertical-jump height, spike-jump height, and SBJ) and agility. Based on our results, it could be concluded that a preseason skill-based conditioning program does not offer a sufficient stimulus for volleyball players. Therefore, a general conditioning and hypertrophy training along with specific volleyball conditioning is necessary in the preseason period for the development of the lower-body strength, agility and speed performance in volleyball players.

**KEY WORDS** team sport, fitness, impact, abilities

## INTRODUCTION

Elite male volleyball players have been reported to perform 250–300 high-power activities during a 5-game match, and the jumps constitute most of the power activities (17). Of these activities, the

attack and block situations represent 45% of the total actions of the game and are also responsible for 80% of the points obtained within international matches (30). Considerable demands are also placed on the neuromuscular system during the various sprints and high-intensity court movement that occur repeatedly during competition (15).

In addition to technical and tactical skills, muscular strength and power are the most important factors that give a clear advantage for successful participation during elite competitions (19). It is believed that to improve their volleyball performance, players must arrange specific volleyball conditioning with some additional resistance and sprint and agility training (23). During the preseason, coaches usually implement a conditioning and training routine in an attempt to maximally prepare their athletes for the upcoming competitive season. Coaches have a limited amount of time to work with their athletes during preseason. Given the short period of time, it is questionable whether athletes can be trained at high intensities and yet properly rest and recover between training sessions to fully achieve the desired effects. Skill-based conditioning is increasingly being used as a means of improving the performance of athletes from skill-based sports (1). The use of skill-based conditioning allows the simulation of movement patterns of team sports while maintaining the physical demands of the game (6). Gabbet (9) showed that skill-based conditioning games that simulate the physiological demands of competition in junior elite volleyball players offer a specific training stimulus. Keeping this in mind, it is of great importance to optimize skill development in volleyball while still obtaining appropriate conditioning levels (24). Gabbet (11) has concluded that skill-based conditioning compared with traditional conditioning has contributed to a reduced rate of injuries, which is of great importance for competitive players.

A number of studies have investigated the effects of different training methods at off-season (8), preseason (25), or during the competitive season in volleyball (3,20,28). In addition, Thissen-Milder and Mayhew (29) showed that selected physiological and anthropometric characteristics could discriminate successfully among freshman, junior varsity, and varsity volleyball teams and starting and nonstarting players.

Address correspondence to Dr. Goran Sporis, gsporis@kif.hr.

26(6)/1475–1480

*Journal of Strength and Conditioning Research*

© 2012 National Strength and Conditioning Association

However, few data are available on skill-based conditioning in volleyball (9,11). Moreover, to our knowledge, no previous study has examined the effect of preseason skill-based conditioning program applied in male competitive volleyball players. In addition, it is unclear whether skill-based training sessions offer an adequate training stimulus to improve the physical characteristics of volleyball players in preseason. Keeping in mind that a season is very long and that there is little time for preparation, skill-based conditioning games offer a sport-specific mode of training for team sports and provide advantages in terms of time efficiency, motivation, and training compliance (13). Therefore, the purpose of this study was to determine the changes in physical performance after a 6-week skill-based conditioning training program in male competitive volleyball players.

**METHODS**

**Experimental Approach to the Problem**

This is a longitudinal study that analyzed the physical characteristics performed by the competitive volleyball players in Serbia after 6 weeks of preseason conditioning program. The players performed a skill-based conditioning program. Having in mind the previous research studies that investigated the effects of skill-based conditioning on physical performance during a season (9,11), it was expected to determine its effects during preseason. Measurements of speed (5 m, 10 m, sprint), muscular power (vertical jump [VJ]), and agility were conducted before and after the training periods. It was hypothesized that there would be a significant improvement between pretest and posttest measurements and that a skill-based conditioning program would result in greater improvements in physical fitness.

**Subjects**

Sixteen male volleyball players participated in this study. The players were members of Volleyball Team “Dubocica” that competes in second Division League in Serbia. Four participants had international experience, and 2 participants were candidates for the under-16 National team, which finished first in the world youth championship in Italy. 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.

**Warm-Up Protocol**

Each athlete performed a standardized 15-minute warm-up consisting of general movements and dynamic and static stretching. After the general warm-up, the players performed assessments of VJ, speed, and agility in random order. After the training program, the subjects were instructed to perform the tests in the same order as they did before the training program.

**Procedures**

The players underwent physical test assessments in an indoor stadium. Before each testing, the subjects performed a standard 15-minute warm-up. During the test, the air temperature ranged from 22 to 25°C. The testing began at 10 AM and finished by 1 PM. Standard anthropometry (height, standing reach height, body mass), lower-body muscular power (VJ and spike jump [SJ], standing broad jump [SBJ]), speed (5- and 10-m sprint), and agility were the physical tests selected. The players were instructed not to be involved in strenuous exercise for at least 48 hours before the fitness testing session and consume their normal pretraining diet before the testing session. None of the subjects were injured 6 months before the initial testing and during the training program. There was no supplement addition regarding the nutrition of the players. In addition, the subjects were not taking exogenous anabolic-androgenic steroids and other drugs that might be expected to affect physical performance or hormonal balance during this study. 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 the lower-body muscular power (VJ, SJ, and SBJ), speed (5- and 10-m sprint), and agility measurements. The subjects performed 2 trials for the speed, agility, and 3 trials for muscular power tests, with a recovery of approximately 3 minutes between trials. The players were encouraged to perform static stretching between trials.

The running speed of players was evaluated with a 5-m (SP5) and 10-m (SP10) sprint effort and measured by means of infrared photocells Uno Lux (The Republic Institute for Sports, Belgrade, Serbia). The timing gates were positioned 5 and 10 m from a predetermined starting point. The players were instructed to run as quickly as possible along the

**TABLE 1.** Descriptive characteristics of the subjects.\*

| Age (y)    | Training experience (y) | Body height (cm) | Body weight (kg) | Standing reach height (cm) |
|------------|-------------------------|------------------|------------------|----------------------------|
| 22.3 ± 3.7 | 8.3 ± 3.5               | 190.7 ± 4.2      | 78.4 ± 4.5       | 240.2 ± 9.1                |

\*Data are reported as mean ± SD.

Downloaded from http://journals.lww.com/nsca-jscr by BMDM5ePHKav1ZEoum1QIN4a+kLhEZgbsH04XMI0hCyw on 05/15/2023

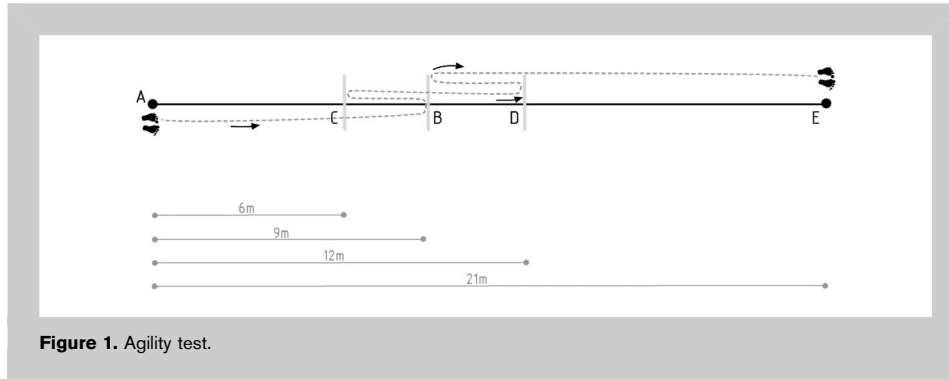


Figure 1. Agility test.

10-m distance from a standing start. Speed was measured to the nearest 0.01 second. The intraclass correlation coefficients for test-retest reliability for the SP5 test and SP10 test were 0.90 and 0.92, respectively.

For the agility with 180° turns, the players started after the signal and ran 9 m from the starting line A to line B (the lines were white, 3 m long, and 5 cm wide). Having touched line B with one foot, they made either a 180° left or right turn. All the following turns had to be made touching the line with the same foot. The players then ran 3 m to line C, made another 180° turn, and ran 6 m forward. Then, they made another 180° turn (line D) and ran another 3 m forward (line E), before making the final turn and running the final 9 m to the finish line (line F) (Figure 1). The intraclass correlation coefficient for test-retest reliability for the agility test was 0.97, respectively.

For the standing reach, while wearing their normal volleyball footwear, the players were requested to stand with their feet flat on the ground, extend their arm and hand, and mark the standing reach height on the vanes of the Vertec (Questtek Corp., Northridge, CA, USA). The players were encouraged to fully extend their dominant arm for the SJ and both hands for

the VJ 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 [centimeters] – standing reach height [centimeters] = relative jump height) (26).

Lower-body muscular power was estimated by the VJ test, the SJ test, and the SBJ. The subject performed 2 types of VJs: (a) the standing VJ and reach for which he dipped to a self-selected depth and then jumped and reached with 2 hands to displace the marker on the Vertec. (b) The SJ with a 3-step approach followed by a takeoff from one leg to reach and displace the marker on the Vertec. Three trials were permitted for all the jumps with the highest jump being used in subsequent statistical analysis. The VJ height and SJ height were measured to the nearest 1 cm. The intraclass correlation coefficients for test-retest reliability for the VJ test and SJ test were 0.97 and 0.98, respectively.

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.

**Training Program**

One mesocycle was analyzed in preseason (season 2009–2010). A short preseason mesocycle (6 weeks) was selected

TABLE 2. Training program used between weeks 1 and 6.

|   |  |
|---|--|
| Goal: skill-based conditioning          |  |
| Sessions 1–18 (Monday–Wednesday–Friday) |  |
| Exercises                               |  |
| Warm-up                                 | 15 min of general activity + warm-up with the ball   |
| Spiking, blocking, digging drills       | 30 min of drills that include low- and high-intensity movements and combine these 3 skills. Two drills were performed with a 2-min break in between.   |
| 3 vs. 3, 4 vs. 4 drills                 | Small-sided (e.g., 3 vs. 3) games where the volleyball court was separated in 2 smaller (9 × 4.5 m) courts.  |
| 6 vs. 6 drills                          | Competition drills (6 vs. 6) with the majority of free balls to each side thrown by the coach. Both teams rotate depending of the scoring. After each rotation, players take 1-min break (40 min). |
| Stretching                              | 5 min of stretching for the muscle groups mainly involved in sessions  |

Downloaded from http://journals.lww.com/nscj-scr by BMDM5ePHKav1ZEoum1QIN4a+kLhEzgbshH04XMI0hCyw CX1AWnYqP/IQHID3I3D00dFy71vSF4cI3vGcA/OAvpDd8KKGKv0Ymy+78= on 05/15/2023

**TABLE 3.** Mean  $\pm$  SD results of different parameters before T1 and T2.\*

| Tests            | T1                 | T2                | <i>p</i> | ES   | %     |
|------------------|--------------------|-------------------|----------|------|-------|
| SP5 (s)          | 1.14 $\pm$ 0.03    | 1.07 $\pm$ 0.04   | 0.00†    | 0.54 | 6.14  |
| SP10 (s)         | 1.92 $\pm$ 0.02    | 1.90 $\pm$ 0.01   | 0.00†    | 0.22 | 1.04  |
| VJ (cm)          | 44.84 $\pm$ 4.15   | 47.09 $\pm$ 3.86  | 0.122    | 0.08 | 5.01  |
| SJ (cm)          | 61.84 $\pm$ 4.90   | 64.69 $\pm$ 4.63  | 0.102    | 0.09 | 4.60  |
| SBJ (cm)         | 227.94 $\pm$ 10.92 | 227.38 $\pm$ 9.39 | 0.877    | 0.01 | -0.24 |
| Agility test (s) | 7.82 $\pm$ 0.49    | 7.58 $\pm$ 0.52   | 0.183    | 0.06 | 3.45  |

\*SP5 = 5-m sprint; SP10 = 10-m sprint; VJ = vertical jump test; SJ = spike jump test; SBJ = standing broad jump; ES = effect size; % = percentage difference between initial and final testing; T1 = experimental period; T2 = after the 6-week experimental period.  
†Significantly different at  $p \leq 0.05$ .

because of the late start of the players' contracts (September) and the early start of the competitions (October). The schedule of the performed preseason conditioning is shown in Table 2. The goals of the preseason conditioning were to increase the intensity of sport-specific training, and attention was paid to volleyball drills and skills. One week before the training program, the players performed the general conditioning to prevent possible injuries. None of the players performed any additional resistance or aerobic training outside of the 3 skill-based sessions. The duration of the training sessions was recorded, with sessions typically lasting 90 minutes. Besides these sessions, 2 low-intensity tactical and skills training sessions were performed. During the 6-week follow-up, the team played 3 friendly preseason matches. For this purpose, different small-sided conditioning exercise and games were selected based on previous experience and pilot studies in which mean exercise intensity responses of traditional drills are suggested by previous authors (9,11). In the first part of sessions (spiking, blocking, digging) conditioning can be achieved by manipulating rest periods, sets, reps, and the nature of the drill (athletes may need to block more than once, cover longer distances laterally to make the block, or make the ball that must be passed harder to retrieve). More complex, skill-based conditioning exercises for volleyball were small-sided games (2 vs. 2, 3 vs. 3) and competition drills (6 vs. 6). Although the duration of each individual rally in this drills was not controlled by the coach, the total duration of the drill can be recorded to assist in intersession and intrasession 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 (18). The coach creates an emotionally intense environment by implementing a scoring system (e.g., team that wins 2 out of the 3 rallies scores 1 big point, 5-second rest) and by encouraging the players.

#### Statistical Analyses

The statistical Package for Social Sciences SPSS (v18.0, SPSS Inc., Chicago, IL, USA) was used for the statistical analysis.

Descriptive statistics were calculated for all experimental data. The Kolmogorov-Smirnov test was used to test if data were normally distributed. For effect size (ES), the partial  $\eta$  squared ( $\eta^2$ ) statistics was calculated and according to Green et al. (14),  $\eta^2$  of 0.01, 0.06, and 0.14 represents small, medium, and large ESs, respectively. Changes in the physical characteristics, lower-body muscular power, speed, agility of players over the training period were compared using one-way univariate analysis of variance.

#### RESULTS

The Kolmogorov-Smirnov test showed that data were normally distributed. Compared with pretraining, there was a significant ( $p \leq 0.05$ ) improvement in the 5- and 10-m sprint. The 5-m sprint time improved by 6.14% after the experimental treatment with a very large ES (0.54). A very large ES (0.22) was found in the variable SP10, but the improvement percentage for the time was only 1.04%. There were no significant differences ( $p > 0.05$ ) between pretraining and posttraining for lower-body muscular power (vertical-jump height, spike-jump height, and SBJ) and agility. A medium ES was found in the variables SJ (0.09) and agility test (0.06), but the percentage difference was much larger in the variable SJ, with 4.6% in contrast to the agility test in which it was 3.45. The smallest ES (0.01) and percentage difference (0.24) were found in the variable SBJ.

#### DISCUSSION

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

The results of fitness characteristics (Table 3) have shown that our players did not significantly differ in speed performance compared with elite volleyball players (7,11). However, the results of jumping characteristics were lower,

which could be the result of several reasons. First, Thissen-Milder and Mayhew (29) showed that selected physiological and anthropometric characteristics could discriminate successfully among freshman, junior varsity, and varsity volleyball teams and starting and nonstarting players, which could suggest a relationship between physical fitness and the playing level attained (29). Second, the greatest improvements in fitness and performance occur when the training stimulus simulates the physiological and technical demands of competition (22), so it could be assumed that this was not the case with the players in our research. The average height of the players is lower compared with the results of elite volleyball players (18,25,26), which agrees with the statement of several researchers that volleyball players differ in anthropometric characteristics according to the level of competition (8,29).

This study found improvements in speed among volleyball players after 6 weeks of skill-based conditioning training. The improved speed in response to training may reflect the highly repetitive nature of selected explosive volleyball skills (e.g., blocking, spiking, digging). Gabbett (11) found that skill-based conditioning games have induced improvements in speed, VJ, SJ, agility, upper-body muscular power, and estimated maximal aerobic power. Gabbett et al. (9) have concluded that skill-based volleyball training improves speed and agility performance, spiking, setting, passing accuracy, spiking, and passing technique, but it 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 (9).

However, it is unclear as to why the skill-based conditioning program failed to improve vertical-jump and spike-jump ability and also the agility. There are a few possible reasons involved in obtaining these results. Rampinini et al. (21) have shown that the intensity of sided games increases while the number of players decreases and this also depends on the playing area, where the game intensity increases when the available game area is decreased, so it is unclear if the improvements would have been better if the stimulus was different or more similar to that of a competitive environment. Another reason could be that volleyball players already have a high level of jumping abilities compared with speed, so the skill-based conditioning games have a greater potential for improving speed. The prolonged season with beach volleyball could also contribute to a high level of jumping abilities. In addition, jumps in volleyball and testing are very similar. Studies of the effect of volleyball and physical conditioning training on the physiological characteristics of players are equivocal, with reports of increased (4,5,16), decreased (15), or unchanged fitness (7) in response to training. Improvements in speed (5), strength (16), and  $\dot{V}O_2\text{max}$  (4,16) have been reported after 5–10 weeks of volleyball and physical conditioning training. However, recent research has demonstrated unchanged speed, agility,

lower-body muscular power, and  $\dot{V}O_2\text{max}$  over a season in talent-identified junior volleyball players (7).

The assessments of agility performance have typically used change-of-direction speed tests, which encompass pre-planned, closed skill movements (27), which is the case with our test. Although preplanned movements are important to team sport performance, a limitation of change-of-direction speed tests is that they fail to assess the perceptual component of agility (12). Because agility is highly specific, there is a need for tests that would include perceptual factors. The perceptual-motor literature strongly suggests that unless the stimulus is sport specific, skilled athletes are unable to use their perceptual skill to advantage (31). Therefore, this could be the reason why an improvement in speed was observed in our subjects, but no improvement was noticed in agility.

Based on previous research, it was suggested that the training-induced adaptations in these types of specific tests (the VJ test and the SJ test) occurred because of the characteristics of the loads applied. In addition, the drills (i.e., service, attack, and block) and matches during all the phases of the macrocycle have contributed significantly to the improvement of the performance in such a specific type of test (28). This was not the case in our study.

The importance of the capacity for attacking and blocking could be seen in the fact that it provides the athletes with better conditions to perform much higher skills above the net, where decisive points are scored, and are determinants for the final result of the volleyball match (2). Thus, elite volleyball athletes are being frequently monitored because their responses can vary largely during systematic training, and to optimize performance, the athletes must be frequently assessed and training loads must be adjusted according to individual needs (28). The present results are therefore limited to Second Division volleyball players and may not be applicable to highly skilled, elite volleyball players. Therefore, further research is required to determine if skill-based conditioning training can improve measures of fitness after a similar training period in highly skilled elite volleyball players. Modern volleyball games are faster and with a lot of back row attacks conducted from opposite and outside hitters. Therefore, it was expected that the players would improve their results in SBJ. However, we found no significant improvement after the skill-based conditioning program.

The skill-based conditioning training program improved players in the 5- and 10-m sprint, but no other physical changes were apparent. Surprisingly, VJ and SJ performance did not increase, despite hundreds of repetitions of jumps in the spike and serve training. Based on our results, it could be concluded that preseason skill-based conditioning program does not offer a sufficient stimulus for volleyball players. Therefore, future research is necessary to further examine the skill-based conditioning and its effects in volleyball. General conditioning and hypertrophy training along with specific volleyball conditioning is necessary during preseason for the development of the lower-body strength, agility, and speed performance in volleyball players.

## PRACTICAL APPLICATIONS

A skill-based conditioning is a common method to accomplish skill development and to improve conditioning level. To our knowledge, this study is the first to investigate the effectiveness of preseason skill-based conditioning programs for improving physical fitness in volleyball league players. It is really difficult to conduct such research among competitive players knowing the importance of competition nowadays. Without proper planning of the conditioning training in the preseason period, volleyball players will most likely be confronted with a decrease in power performance during the in-season period. The results of this study demonstrate that preseason skill-based conditioning does not represent an effective method of conditioning for volleyball league players. Coaches may use the results of this study to plan specific conditioning programs for volleyball players. These results suggest that only skill-based conditioning program could not be enough for the improvement of physical performance in volleyball players. Therefore, a combination of strength training and skill-based conditioning could be a better stimulus for specific volleyball conditioning. Therefore, a combination of strength training and skill-based conditioning should be implemented to enhance physical performance in volleyball.

## REFERENCES

- Allison, S and Thorpe, R. A comparison of the effectiveness of two approaches to teaching games within physical education. A skills approach versus a games for understanding approach. *Br J Phys Educ* 28: 9–13, 1997.
- Beal, D, Peppler, MJ, and Kessel, L. *Coaching Tips for the 90's*. Evanston, IL: The Sports Group, 1990.
- Bloomfield, J, Polman, R, O'Donoghue, P, and McNaughton, L. Effective speed and agility conditioning methodology for random intermittent dynamic type sports. *J Strength Cond Res* 21: 1093–1100, 2007.
- Fardy, PS, Hritz, MG, and Hellerstein, HK. Cardiac responses during women's intercollegiate volleyball and physical fitness changes from a season of competition. *J Sports Med* 16: 291–297, 1976.
- Franks, BD and Moore, GC. Effects of calisthenics and volleyball on the AAHPER fitness test and volleyball skill. *Res Q* 40: 288–292, 1969.
- Gabbett, T. Skill-based conditioning games as an alternative to traditional conditioning for rugby league players. *J Strength Cond Res* 20: 309–315, 2006.
- Gabbett, T and Georgieff, B. Physiological characteristics of elite junior volleyball players over a competitive season. *Strength Cond Coach* 13: 2–7, 2004.
- Gabbett, T and Georgieff, B. Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players. *J Strength Cond Res* 21: 902–908, 2007.
- Gabbett, T, Georgieff, B, Anderson, S, Cotton, B, Savovic, D, and Nicholson L. Changes in skill and physical fitness following training in talent-identified volleyball players. *J Strength Cond Res* 20: 29–35, 2006.
- Gabbett, TJ. Training injuries in rugby league: An evaluation of skill based conditioning games. *J Strength Cond Res* 16: 236–241, 2002.
- Gabbett, TJ. Do skill-based conditioning games offer a specific training stimulus for junior elite volleyball players? *J Strength Cond Res* 22: 509–517, 2008.
- Gabbett, TJ, Sheppard, JM, Pritchard-Peschek, KR, Leveritt, MD, and Aldred, MJ. Influence of closed skill and open skill warm-ups on the performance of speed, change of direction speed, vertical jump, and reactive agility in team sports athletes. *J Strength Cond Res* 22: 1413–1415, 2008.
- Gamble, P. Challenges and game-related solutions to metabolic conditioning for team sports. *Strength Cond J* 29: 60–65, 2007.
- Green, SB, Salkind, NJ, and Akey, TM. *Using SPSS for Windows: Analyzing and Understanding Data* (2nd ed.). Upper Saddle River, NJ: Prentice Hall, 2000.
- Häkkinen, K. Changes in physical fitness profile in female volleyball players during the competitive season. *J Sport Med Phys Fitness* 33: 223–232, 1993.
- Hascelik, Z, Basgoze, O, Turker, K, Narman, S, and Ozker, R. The effects of physical training on physical fitness tests and auditory and visual reaction times of volleyball players. *J Sport Med Phys Fitness* 29: 234–239, 1989.
- Hasegawa, H, Dziados, J, Newton, RU, Fry, AC, Kraemer, WJ, and Häkkinen, K. Periodized training programmes for athletes. In: *Strength Training for Sport*. WJ. Kraemer and K. Häkkinen, eds. London, United Kingdom: Blackwell Science, 2002. pp. 69–134.
- Marques, MC, Van den Tillaar, R, Gabbett, TJ, Reis, VM, and Gonzalez-Badillo, JJ. Physical fitness qualities of professional volleyball players: Determination of positional differences. *J Strength Cond Res* 23: 1106–1111, 2009.
- Marques, MC, Van den Tillaar, R, Vescovi, JD, and Gonzalez-Badillo, JJ. Changes in strength and power performance in elite senior female professional volleyball players during the inseason: A case study. *J Strength Cond Res* 22: 1147–1155, 2008.
- Moir, G, Button, C, Glaister, M, and Stone, MH. Influence of familiarization of the reliability of vertical jump and acceleration sprinting performance in physically active men. *J Strength Cond Res* 18: 276–280, 2004.
- Rampinini, E, Impellizzeri, F, Castagna, D, Abt, GA, Chamari, K, Sassi, A, and Marcora, M. Factors influencing physiological responses to small-sided soccer games. *J Sports Sci* 25: 659–666, 2007.
- Rushall, BS and Pyke, FS. *Training for Sport and Fitness*. Sydney, Australia: MacMillan, 1990.
- Scates, A and Linn, M. *Complete Conditioning for Volleyball*. Champaign, IL: Human Kinetics, 2003.
- Sheppard, JM and Borgeaud, R. Skill based conditioning: A perspective from elite Volleyball, NSCA 2009. Available at: [www.nasca-lift.org/HotTopic/download/SkillBasedConditioning.pdf](http://www.nasca-lift.org/HotTopic/download/SkillBasedConditioning.pdf). Accessed 2010.
- Sheppard, JM, Cronin, JB, Gabbett, TJ, McGuigan, MR, Etxebarria, N, and Newton, RU. Relative importance of strength, power, and anthropometric measures to jump performance of elite volleyball players. *J Strength Cond Res* 22: 758–765, 2008.
- Sheppard, JM, Gabbett, TJ, and Reeberg Stanganelli, LC. An analysis of playing positions in elite men's volleyball: Considerations for competition demands and physiologic qualities. *J Strength Cond Res* 23: 1858–1866, 2009.
- Sheppard, JM and Young, WB. Agility literature review: Classifications, training and testing. *J Sports Sci* 24: 919–932, 2006.
- Stanganelli, LCR, Dourado, AC, Oncken, P, Mancan, S, and da Costa, SC. Adaptations on jump capacity in Brazilian volleyball players prior to the under-19 world championship. *J Strength Cond Res* 22: 741–749, 2008.
- Thissen-Milder, M and Mayhew, JL. Selection and classification of high school volleyball players from performance tests. *J Sport Med Phys Fitness* 31: 380–384, 1991.
- Voigt, H and Vetter, K. The value of strength-diagnostic for the structure of jump training in volleyball. *Eur J Sport Sci* 3: 1–10, 2003.
- Young, W and Farrow, D. A review of agility: Practical applications for strength and conditioning. *Strength Cond J* 28: 24–29, 2006.