CASE STUDIES

IST protocols for jump performance in male volleyball Olympic training

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The challenge: background to the study

For many sports the Olympic Games are the pinnacle of competition; team and individual success is often judged by how well they perform at the Games. Consequently, ensuring that athletes enter the games in peak physical condition, but also at a peak in terms of their tactical and technical proficiency is paramount. Thus, in the latter stages of build-up to the Games, prioritising technical and tactical development must be the priority. However, in focusing solely on these areas, there is an inherent danger that the physical capacities that have been developed during the preparation for these games may start to reverse. In an ideal world we would be able to continue to build the physical capacities, while also developing technical and tactical prowess, but this provides a number of challenges.

Elite level athletes often require substantial stimulating loads in order to continue to elicit performance gains, and this can require significant time allocation and also elicit high levels of fatigue. Similarly, pushing athletes beyond current capacities always caries a risk of injury, which can be catastrophic for both the individual involved and for the team. However, if insufficient load allocation is devoted to physical conditioning, then training gains will be reversed and athletes may enter the Games in a state of deteriorating fitness. Coaches thus have to make philosophical decisions based on a cost-benefit analysis and with decisions made across multiple criteria. Essentially, the decisions revolve around two broad approaches: 1) do we continue to push physical development, with the associated potential of being in the best physical condition ever, but risking fatigue and eating into technical and tactical time allocation? Or 2) do we maintain current condition and focus on ensuring that tactical and technical optimisation is emphasised alongside controlling fatigue? Clearly, these decisions cannot be made in isolation and to a large extent they will be dictated by the head coach and their team.

WHY PHYSICAL CONDITIONING WAS IMPORTANT

Volleyball consists of a series of explosive actions, characterised by short bouts of high-force production, interspersed with brief rest periods over the course of a match lasting 60 to 90 minutes. To successfully perform technical skills such as spiking, blocking and serving, the player's vertical jump performance is a critical component – specifically the countermovement jump (CMJ) and the spike jump (SPJ).[7] Over a five set match, players may average 65 to 136 jumps amounting to between 30,000 to 40,000 jumps over a year.[3] Therefore, along with the energy system demands, volleyball players require muscular endurance and power in order to optimise their performance to express force frequently and quickly.[4] Enhancing these capacities is crucial for volleyball performance and typical methods of developing power and jump performance in volleyball players include conventional strength training, plyometrics, loaded jumps, sprints and Olympic weightlifting.[4]

THE APPROACH TAKEN

In discussions with the coaching staff, it was clear that their preferred final preparation approach for the games was to allocate as much of the available time as possible to technical and tactical components, while aiming to minimise fatigue. This left little opportunity for physical conditioning and therefore an approach needed to be developed that allowed the maintenance of key physical parameters in as time efficient a manner as possible.

From a physical standpoint, the key components that needed to be trained were the maintenance of the key force capacities highlighted earlier. A crucial aspect to consider was that volleyball training and competition include a high volume of jumps. Consequently, dedicated plyometric training was omitted from the schedule and it was felt that the implementation of additional plyometric training may have further increased the physiological stress, increasing fatigue and potentially causing acute and chronic overuse injuries. In a similar way, as the game schedule could typically maintain the endurance capacities required to sustain performance, additional endurance work was not emphasised.

The focus therefore shifted to maintaining underlying force capacities in as time-efficient a manner as possible, thereby minimising undue fatigue and reducing injury risks. Isometric exercises have been proposed as a method by which to maintain and develop force capacities, while at the same time avoiding the neuromuscular and metabolic damage[2] that can occur with traditional power training methods such as plyometrics and Olympic weightlifting. Furthermore, isometric exercises may contribute to improving musculotendinous stiffness, and transfer to sport-specific tasks.[6] Methods of isometric strength training (IST) include rapid non-sustained contraction (RIST) and sustained contraction (SIST). The former requires each repetition to be performed maximally for approximately one second, whereas the latter requires a sustained maximal contraction for up to three seconds.[5] It was felt that in the given scenario, IST could provide a solution for the challenge by maintaining key physical skills such as strength, power and speed with minimal neuromuscular stress.

The course of action pursued

Due to the constraints of national team training, only three weeks of preparation involving all squad members were available before playing competitive fixtures. The final squad involved 16 elite volleyball players: Table 1 details the players' characteristics.

During the preparation period, it was important to be able to monitor performance to allow adjustments to the protocols to be made and a Chronojump (Bosco-System, Barcelona, Spain) jump mat was used to measure jump height. Efficiency was stressed throughout the period and so it was crucial that no time or energy was wasted on activities that would not contribute to performance. To facilitate this, a RAMP warm-up protocol was used with each activity planned to contribute in some way to performance, both in the upcoming session and in the overall preparation. The protocols were also planned to avoid superfluous activities that may have contributed to fatigue but had limited effect on performance.

Table 1: Players' characteristics at baseline. Values are reported as mean ± SD

VARIABLE	INTERVENTION GROUP
N	16 males
Age, year	20 ± 1
Height, cm	196 ± 9
Body mass, kg	78.04 ± 9.27
BMI, kg/m2	25.02 ± 2.00

Table 2: Warm-up protocol prior to CMJ testing

PHASE	EXERCISE OR DRILL	PRESCRIPTION
Raise heart rate	Light movement honing – forwards, backward, side shuffles, jockeying	5 minutes
Activate and mobilise	Mini band lateral shuffle	1 x 8 each side
	Floor glute bridges	1 x 8
	Quadruped thoracic spine extension	1 x 6 each side
	Bodyweight squats	1 x 10
	Multi-planar lunge circuit	1 x 6 each side
	Single leg squat	1 x 5 each side
Potentiate	Bilateral broad jump and stick	1 x 2
	Triple broad jump (Stick final landing)	1 x 2 each side
	Bilateral countermovement jump	1 x 2

Table 3: IST protocol

DAY 1		DAY 2		DAY 3	
EXERCISE	SETS X REPS	EXERCISE	SETS X REPS	EXERCISE	SETS X REPS
Isometric squat 90°	3 x 5 (3s contraction)	Isometric squat 90°	3 x 5 (3s contraction)	Isometric squat 90°	3 x 5 (3s contraction
Isometric squat 120°	3 x 5 (3s contraction)	Isometric squat 120°	3 x 5 (3s contraction)	Isometric squat 120°	3 x 5 (3s contraction)

Table 4: Example individualised programme following IST

DAY 1		DAY 2		DAY 3	
EXERCISE	SETS X REPS	EXERCISE	SETS X REPS	EXERCISE	SETS X REPS
Single leg	3 x 5 each	Romanian deadlift	3 x 5	Bulgarian split squat	3 x 5 each
Squat	4 x 5	Pull up	4 x 8	Incline	4 x 6
Dumbbell bench press	4 x 8	Farmer's walk	4 x 15m	Dumbbell bench press	4 x 8 each
Dumbbell row	3 x 8	Weighted twists	3 x 10 each	Single arm row	3 x 3 each
Hip thrust	3 x 15				
Single leg calf raise				Turkish get-up	

'if insufficient load allocation is devoted to physical conditioning, then training gains will be reversed'

Table 5: Changes in countermovement jump performance. Values are reported as mean ± SD

	INTERVENTION GROUP				
VARIABLE	PRE	POST	Δ [%]	P	EFFECT SIZE (D)
CMJ height, cm	49.57±7.99	49.53±7.05	-0.08±6.02	0.97	0.01

The three-week training programme consisted of three S&C sessions per week performed concurrently with volleyball technical and tactical training. The isometric strength training protocol (Table 3) consisted of two isometric squat exercises performed at 90° and 120° knee flexion within the same session. Athletes performed three sets of five repetitions of each exercise with a three-second contraction – with repetitions separated by 10 seconds, followed by two minutes rest between sets.[5] The remainder of the athlete's session involved an individualised training programme (see Table 4) focused on injury prevention.

The results

The results of the intervention are shown in Table 5. When the group data was assessed statistically, there was no statistically significant change in CMJ height from pre-intervention measurement (49.57 ± 7.99cm) to post-intervention measurement (49.53 ± 7.05cm), t = 0.04, p = 0.97. The results demonstrated the mean decrease in CMJ score was 0.03, with a 95% confidence interval ranging from -1.72 to 1.79. Cohen's d (0.01) indicated a trivial effect size. Although statistical studies do report group data, for coaches what is of far more importance are the individual responses, as these have to be modified to ensure each player reaches the games in their optimal condition. Figure 1 illustrates the individual results pre- and post-IST intervention.

Although the mean decrease in CMJ performance across the squad was trivial, the individual responses are a mixture of positive, negative and neutral. Some players saw improvements in jump performance, some maintained their performance and some decreased. Although the exact reasons for this are unclear, there are some points that will be discussed later.

Discussion and lessons learnt

The aim of this intervention was to investigate the effect of a three-week training programme incorporating isometric strength training (IST) on jump performance with a group of elite volleyball players preparing for competition. The IST was substituted for traditional bilateral lifts such as squats and deadlifts to minimise the metabolic and neuromuscular stress while prioritising technical and tactical development. Statistical analysis of jump performance found there was no significant difference between pre- and post-intervention on CMJ height (pre 49.57±7.99 cm, post 49.53±7.05 cm, p = 0.97).

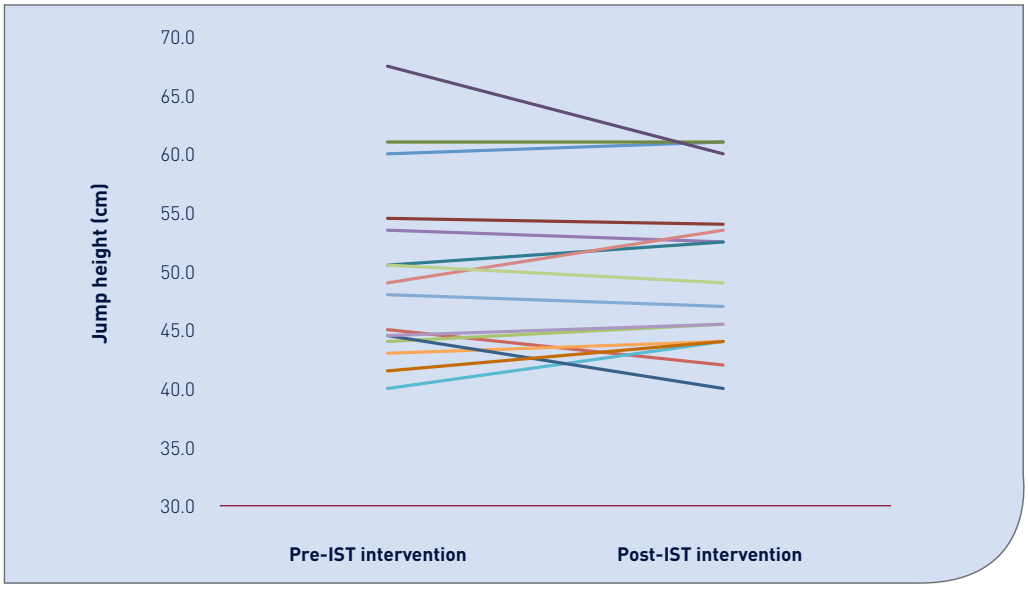

Figure 1. Individual results pre- and post-intervention

Training and competition in volleyball and other team sports has been shown to cause muscular and neural fatigue and subsequently decrease physical capacity. With additional strength and conditioning sessions, this fatigue could be increased; however, with IST, there is reduced neuromuscular demand, lack of eccentric lengthening, and decreased metabolic cost compared to traditional strength-power training, allowing for the maintenance of key physical skills such as strength, power and speed.[5,6]

The specific isometric training protocol required athletes to perform a three-second maximal contraction for five repetitions for a total of 15 seconds contraction time. The length of contraction agrees with previous methodology that led to a significant improvement in CMJ performance.[5] However, although average jump performance was maintained, there were both positive and negative individual responses. The players had an extensive training history, but some of them were unfamiliar with IST. The specific protocol required a maximal contraction and we found this to vary from player to player depending on how motivated they were. Potentially, performing the protocol using force plate technology would provide feedback on performance and external motivation.

The advanced training history of some players was perhaps one reason for the negative effect on jump performance in that the prescribed protocol was not sufficient stimulus for the particular athlete. Further arguments against IST is that adaptations are joint specific and therefore the reason why 90° and 120° knee flexion was chosen to ensure transferability of training.[6] Some of the disadvantages of IST were potentially negated through the continued programming of unilateral, lower body dynamic training. Although the external loading may be less, the increased stability requirement and neuromuscular control of unilateral exercises can improve strength in a bilateral movement.[1] However, this also means that the results cannot be totally attributed to the IST protocols

Although the intervention provided mixed results, the overall subjective measures of RPE and wellness from players were reduced compared to similar training camps. The removal of heavy bilateral lifts and eccentric loading reduced the perceived intensity of the session while also reducing muscle soreness. Similarly, coaches responded favourably to the protocol by understanding the need to maintain key physical qualities without inducing the metabolic and neural stress that can impact technical and tactical sessions.

Practical applications

Although the three-week intervention of isometric strength training, using 15 seconds of sustained contraction in two isometric squat exercises with knee flexion at 90° and 120°, did not improve CMJ height during a final international volleyball training camp, it was able to maintain performance in most athletes. Therefore, the inclusion of isometric strength training may help to preserve neuromuscular qualities and maintain vertical jump performance, while importantly minimising fatigue and injury risk, as well as allowing for greater time to be devoted to sport-specific preparation.

As such, it may be a useful tool for coaches in similarly restricted scenarios. However, there was some variance in individual responses and this needs to be factored in to any approach, with individual variations made based on these observations. For example, highly trained athletes may require greater neuromuscular and metabolic stimulus through increased frequency, volume and/or intensity of isometric training to have a positive effect on jump performance. Therefore, key elements of the training protocol such as intensity and volume, as well as different contraction protocols such as sustained or ballistic, should be prototyped. In addition, the ability to quantify the isometric contract would improve motivation and athlete intent. Similarly, external factors such as the exact volume of concurrent technical and tactical training should be taken into consideration. As with many strength and conditioning interventions, a 'one size fits all' approach is seldom optimal.

AUTHORS' BIOGRAPHIES

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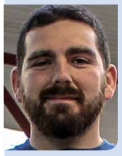
Tomasz is a Polish strength and conditioning coach who completed his undergraduate degree in S&C through the University of South Wales, UK and has recently completed his postgraduate degree in performance coaching through Setanta College, Ireland. Tomasz is also accredited with the UKSCA and ASCA Level 2 as well as EXOS performance specialist. Tomasz has spent several years coaching in Monaco and Poland with individual athletes and teams across the several sports such as: Mixed Martial Art, soccer and volleyball.



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Ryan is currently a S&C coach with the Sport Northern Ireland Sports Institute, working across swimming, judo, para-badminton and wheelchair basketball. Previously, Ryan worked with a number of male and female team sports, from junior to senior level, in rugby, football, futsal, hockey and Gaelic football.

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Wojciech is a S&C coach with over eight years of experience in PlusLiga, the highest level of men's volleyball in Poland. He graduated from the University of Physical Education in Kraków. Wojciech was responsible for the athletic preparation of the Polish National Volleyball Team for Tokyo 2020 Olympic Games.

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