

STRENGTH TRAINING IN HANDBALL

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WHY STRENGTH TRAINING IS IMPORTANT

Handball is a fast-paced body-contact Olympic sport, played by two competing teams of seven players (one player is a goalkeeper) on an indoor court (40 × 20 m) over two 30-minute periods. It is generally recognised that due to relatively recent changes in game rules (e.g. starting the game quickly from the centre) and improvements in the tactical use of rolling substitutions, the intensity of the game is increased. Players are also able to perform more high-intensity actions. Despite its popularity, a paucity of data exists to describe the game's physical demands. What is clear is that anthropometric characteristics of the players vary depending on the position they play with backcourt and line players (pivot) being taller and heavier than wingers^{1,2}. Time-motion data from the elite men's game

during the 2007 World Championships has indicated that playing time is different between positions with wingers (37.37 ± 2.37 minutes) and goalkeepers (37.11 ± 3.28 minutes) having more court time than either backcourt players (29.16 ± 1.70 minutes) and pivots (29.3 ± 2.70 minutes).

The total distance covered during the game also varies between positions with larger distances covered by wing players (3710 ± 210 m) when compared to backcourt (2839 ± 150 m) and line player (pivot) (2786 ± 238 m) positions. More recent research on elite male handball players has shown that players cover a mean distance of 4370 ± 702 m during a game, most of which is spent performing low intensity actions that is interspersed by short duration, very high-intensity anaerobic actions³. Such actions define the most important aspects

of the game, as they represent offensive or defensive situations needed to score a goal and/or avoid conceding one. To our knowledge, extremely limited information exists to date to describe the physical demands within the elite women's game, but it is likely that similar patterns exist and clear signs of fatigue can be observed towards the end of the game. The aim of this article is to consider how strength training can improve performance and reduce the risk of injuries, taking into consideration the demands of modern handball.

THE GAME

Research and notational analysis of international games clearly indicates that handball players perform a large number of high intensity actions during a game⁴⁻⁶. Such actions are characterised by

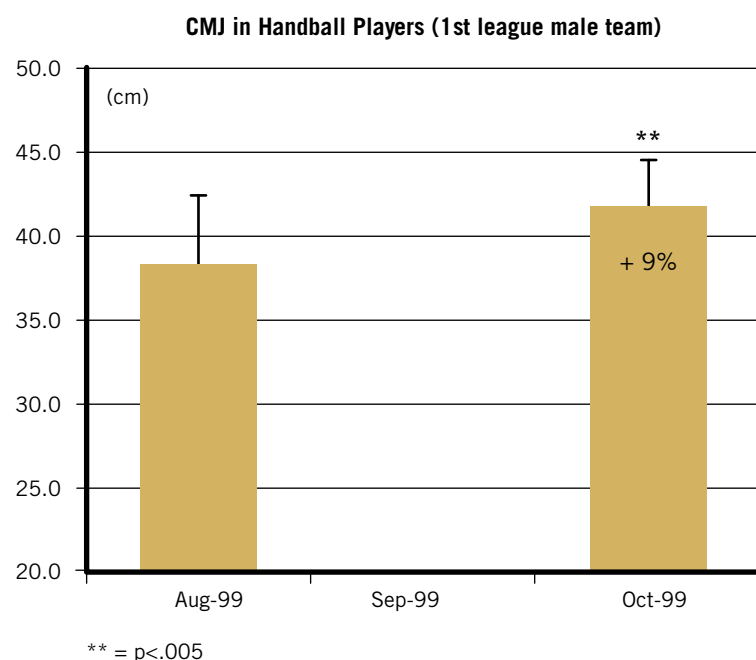


Figure 1: Counter movement jump following 14 strength training sessions in handball players from the Italian 1st league in pre-season training.

accelerations and decelerations in various directions (including cutting movements) and jumps and landing activities. All such movements require forceful muscle actions and can be repeated more than 100 times during the course of one game. For this reason, it is important to consider the strength requirements of these typical movement patterns in order to define the most appropriate approach to implement a successful strength training programme. Furthermore, due to the fact that physical contact is allowed within the rules of the game, strength requirements are quite high in order to sustain the physicality of the game and the high risk of injury as documented in the last survey conducted at the London 2012 Olympic Games⁷.

Jump shots

Jump shots, for example, are the most used shooting technique by handball players (more than 70% of the shots are performed while jumping⁸) and are performed with a run-in, planting of the foot and take off, usually on the opposite leg to the throwing arm (albeit some players at times will perform jump shots taking off with both lower limbs and/or jumping on the leg on the same side of the shooting arm). Ground reaction forces measured in handball players performing one leg take off after a run-in have shown values larger than 3×

the player's body mass with ground contact times shorter than 300 milliseconds⁹⁻¹¹. This means that muscles of the lower limbs are required to produce large contractile forces in a relatively short period of time in order to facilitate longer fly times. An increased jumping ability on one leg would be a big advantage for a player, as it would allow shooting from a bigger height with the possibility to avoid a block from a defender (mainly backcourt players) and would give more time in the air to wait for a goalkeeper's move or fake a shot (mainly for wings, line players and other game-specific situations). Strength training should therefore be targeted to improve vertical jumping ability in handball players, however other aspects related to injury prevention should be taken into account. Due to the kinetics and kinematic characteristics of jump shots, and the large number of repetitions of such actions in training, stronger lower limbs are particularly necessary as braking forces are large during the deceleration phase and stress on the ankle and knee joint is quite remarkable^{9,10}. This is particularly important after landing from such shots and when landing is affected by contact with a defender from the opposite team.

Bi-weekly strength training programmes conducted in-season have been shown to be quite effective in improving force and the power-generating capacity of the muscles of

the lower limbs in elite handball players^{12,13}. In our experience, 12 to 14 sessions alternating 2 and 3 sessions of strength training per week with a progressive individualised training programme was effective in improving vertical jumping ability in an Italian elite league team (Figure 1, unpublished data) suggesting that carefully planned strength and conditioning sessions can be effective even in well-trained players. As already indicated in 1997¹⁴, well-planned and individualised strength training programmes can improve vertical jumping abilities in a relatively short period of time in young and more experienced players.

Benefits for prevention

Strengthening the lower limbs is also important for injury prevention purposes. Few studies have shown that a training programme combining strength training, proprioceptive training and jumping and landing exercises can be effective in reducing injuries in male and female handball players¹⁵⁻¹⁷. Strengthening the lower limbs is in fact not only important for vertical jumps and jump shots but also to prepare the players to perform the rapid changes of directions and cutting movements performed during training and competition. In such movements, players are accelerating forward and then suddenly try to change direction to avoid a defender. High levels of strength are required to decelerate and then accelerate in another direction. Therefore strength training should be targeted to allow handball players to be able to decelerate safely and accelerate in various directions minimising the risks of injury. It is in fact during such movements that the risks of ACL injuries are very high in handball players (in particular in female players)¹⁸⁻²⁰. Strength training programmes should then be designed to include exercises with one and two limbs, landing and deceleration drills, generic proprioceptive-type of exercise on stable and unstable surfaces and eccentric and plyometric drills in various directions. Strength training plans designed with this approach have been shown previously to reduce the risks of injuries^{15,17,21} and it is important to stress the fact that players should be able to perform rapid decelerations and accelerations in every possible direction with an appropriate

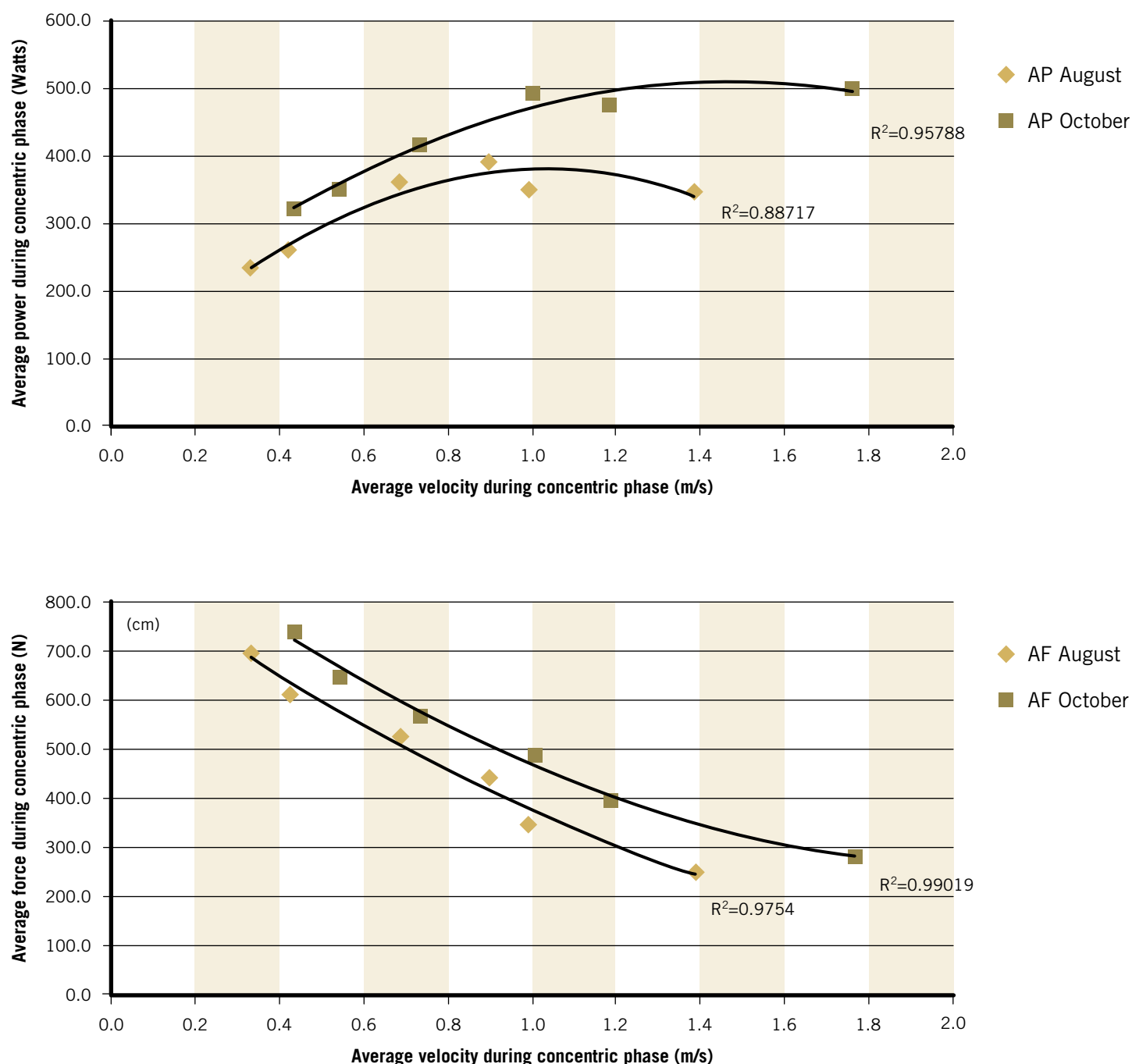


Figure 2: Force-Velocity and Power-Velocity relationship measured with Bench Press (increasing loads from 20kg to 80kg) in Handball players (n=10) after 14 strength training sessions in pre-season in the Italian Handball League.

movement pattern and control of the ankle and knee joint in order to reduce the chances of an injury.

Goalkeepers

Goalkeepers tend to be neglected in many studies, so little is known about the overall physical demands of playing such position. Despite the very small overall displacement on court, goalkeepers perform

a lot of quick movements in the goals to perform saves. Such movements are mostly performed from static positions and require explosive actions generated by the lower limbs. Goalkeepers typically perform 10 to 17 saves per game at international level²². Considering that the typical shot can be faster than 100 km/hour, it is clear that quickness combined with anticipatory skills are necessary physical attributes needed

to excel at the elite level. A recent study²³ has shown that the time taken by expert goalkeepers to begin a vertical movement of their centre of mass, relative to the moment of the ball's release, was less than the time taken by inexperienced goalkeepers (77 ± 70 vs 141 ± 108 ms, respectively). This suggests that expert goalkeepers wait longer before moving than do inexperienced goalkeepers and for this reason can greatly benefit from

strength training programmes capable of improving explosive abilities of the lower limbs.

UPPER BODY STRENGTH

Upper body strength is of paramount importance for handball players for two main reasons:

1. Throwing speed and reduction of the risks of injury of the throwing shoulder.
2. Ability to perform effective defensive interventions.

Few studies and our own observations with national teams and club teams in Italy have, in fact, shown over the years that throwing speed could discriminate between elite and non-elite players^{24,25}. Upper body strength, assessed dynamically by means of bench press 1RM and lifting velocity with various loads, has been shown to be predictive of throwing speed in handball players^{26,27} (Cardinale unpublished observations). For this reason, a training programme designed to improve upper body strength could then use the bench press as one of the exercises not only for training purposes but also to assess the progression and the effectiveness of the programme. In our experience, 12 to 14 sessions of strength training including unilateral and bilateral bench press and other exercises for the shoulders and upper body (always performed with the intent to move the load as fast as possible, independently from the external load) in pre-season in a team of the Italian elite league was successful in shifting the force/velocity and power/velocity relationships to the right and improved throwing speed (Figure 2). Furthermore, a multi-annual programme focused on strength in the first year and on speed and power in the following years was effective in shifting the force/velocity and power/velocity curves to the right with large improvements in power output linked to improvements in throwing speed in a national team player (Figure 3). Few studies have shown that throwing speed and upper body strength can be improved by a well-planned bi-weekly training programme implemented during the competitive season^{4,13,28}. Medicine ball training, typically used for training handball players, should be introduced with caution despite its potential to positively affect throwing performance²⁹. This is because, in our view, the shoulder should be strengthened appropriately before an overload is applied to the

throwing motion. Significant imbalances in shoulder muscles have, in fact, been shown in handball players as a consequence of their normal handball training³⁰ and such imbalances present a larger risk of injury³¹. Therefore, the suggestion is to strengthen the shoulder and make sure that appropriate conditioning is in place before overloading it with heavier balls and high volumes of throwing activities.

Typical exercise prescription should include, together with the bench press, shoulder press exercises, internal and external rotations against resistance with various angles, speeds and external loads, pull-over type exercises and exercises targeting the muscles of the thoracic spine and scapulae. Throwing speed and injury prevention for the shoulder are not the only reasons for introducing strength training as part of a handball player's training programme. Upper body and core strength are, in fact, necessary for effective defensive movements required to stop opponents in defensive actions and have been suggested to be necessary attributes for elite handball players, in particular for defense specialists.

Finally, upper body strength is very important for goalkeepers. Elbow problems also termed 'handball goalie's elbow' are a common occurrence. Upper body strength training programmes should therefore be individualised for goalkeepers to protect not

only the shoulder but also the elbows and wrists due to the extreme repetitive impact loads of the muscles around those joints.

TRAINING PLANNING

It is clear that there is a paucity of studies involving handball players and more effort is needed from the scientific community to understand more about the physical demands of the game and the potential to modify and individualise training in order to improve performance and reduce the risks of injury. In particular, little is known about the most appropriate approaches for a periodised strength training programme in teams involved in national and international competitions (where players can play a large number of games within a season).

In our experience, strength training can be performed weekly with one to three sessions per week according to the playing schedule in professional teams. This requires appropriate planning with the coaching team and needs to take into consideration the overall loading patterns experienced by the players in order to avoid overreaching or the occurrence of overtraining. Generally, two sessions per week can be useful to improve strength and power in well-trained individuals, with three sessions per week being more appropriate in pre-season or intensive preparation periods. Single

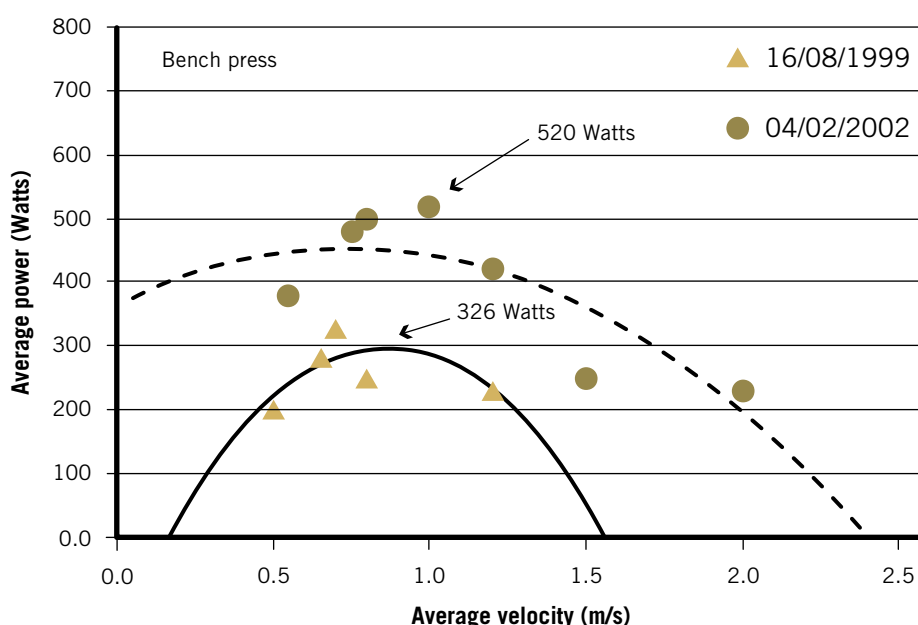


Figure 3: Bench press P-V relationship in one national team player over the course of 4 years. Note the large improvements in Peak Power which were related also to improvements in throwing speed.

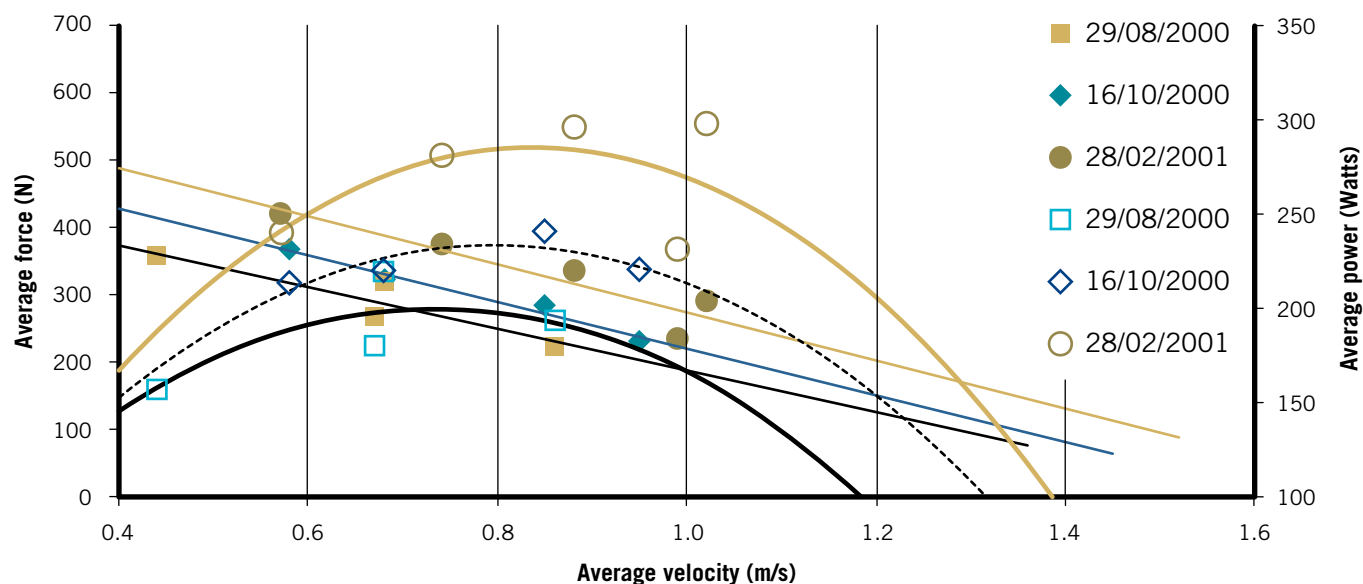


Figure 4: Force/velocity and power/velocity relationship measured in a national team female handball player undergoing a strength training programme over the course of a competitive season. Note the improvement in peak power.

sessions per week are unlikely to produce significant improvements in strength and power, but can be useful to maintain strength and power levels in well-trained players.

As a general rule, new strength training exercises (involving heavy loads and new movement patterns) should not be introduced in-season too close to competitive games, due to the likelihood of delayed onset of muscle soreness which can impair performance and also increase the injury risk. Rather, they should be introduced at the beginning of the week, more than 96 hours before a game. The best approach to individualise strength training programmes for handball players is to assess their strength and weaknesses, be aware of the injury history and design an individualised progression which takes into consideration the need to develop strength capabilities which can positively affect performance and can protect the athlete from injury.

The typical weekly schedule with one game per week on a Saturday might include two strength sessions one on Monday and one on Wednesday or Thursday morning with more emphasis on heavy loads at the beginning of the week. Load progression in-season should always include some elements of heavy strength training combined with external loads corresponding to the load in which the athlete produces the

maximum power (e.g. determined with bench press with increasing external loads for the upper body). The emphasis can change over the course of the season, favouring larger volumes of heavier loads (>80% of 1RM) at the beginning of the season and shifting gradually to larger volumes of lighter loads (loads maximising power output ranging from 35 to 65% of 1RM) and more explosive movements towards the end of the season with an overall reduction of training volume towards the play-offs. In our experience, this approach was effective in improving force/velocity and power/velocity relationships measured with squats and bench presses over the course of the season with the athletes producing the highest values closer to play-off times (Figure 4).

CONCLUSIONS

Strength training is of fundamental importance for handball players. An effective training programme has the potential not only to improve performance but also to significantly reduce the risk of injuries. It is important to note that there is a paucity of data in the literature on handball, and more needs to be done in order to understand the most effective training prescriptions for elite handball players involved in national and international competitions during very long seasons. Despite the limited information available, it is clear that strength training

programmes can produce beneficial effects when strength training is maintained during the sporting season. Furthermore appropriate loading patterns and variety of exercise prescription is needed due to the specific needs of the sport and the specific requirements of playing positions. Strength and conditioning coaches should always assess the athletes in order to identify strengths and weaknesses and monitor the effectiveness of the training prescriptions using dynamometry and assessing vertical jumping abilities and throwing speed when possible. Some of the methods indicated in this short article have been very useful to assess progression, not only over the course of the season but also over the years in players of international calibre. However, it should be reminded that improvements in the gym (e.g. personal bests in 1RM) are only significant if they have a direct influence on handball-specific elements (e.g. throwing speed, jumping ability and/or reduction in injury rates).

References at www.aspetar.com/journal

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