

STRENGTH, A FUNDAMENTAL MOTOR QUALITY IN HANDBALL

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Abstract

Coaches involved in strength training, a prerequisite of modern training, are expected to possess knowledge of physiology, anatomy, biomechanics, sports training theory, as well as rich practical experience. This is why, in this article, we tried to systematize this knowledge and to emphasize the general essential aspects related to strength as a motor capacity, namely to its manifestation forms, the factors influencing it, the training methods used to develop it, the evaluation of its parameters and the workout planning and programming.

Key-words: methods, training, contractions, planning, programming

1. Introduction

In sports games, a great emphasis has lately been placed on physical training, in general, and particularly to the strength training methods. Strength, under its various manifestation forms, represents the central element within the wide range of the motor capacities required in sports.

During the workouts, modern players are submitted to loads quantitatively and qualitatively more strenuous than in the past, in order to increase game efficiency. The physical training methods suggest that strength could be developed either with or without loads or by means of plyometric exercises. Tendon or joint muscular structures have to cope with some increased exertions. That is why in any physical exercise performed by an athlete, his age, his training stage and the manifestation form of the strength to be developed need to be taken into account. Another criterion that has to be considered while during strength increase in athletes through practicing sports games is the risk involved when performing strength exercises.

According to a multiple-criteria classification made by L. Teodorescu (1975), sports games are divided into:

- individual and collective;
- by hand: directly (volleyball, handball), with a device (tennis, hockey);
- by foot (football);
- mixed: by hand and by foot (rugby);
- by normal movements or by locomotion means;
- by fighting for the ball - directly (handball, football) or indirectly (volleyball, tennis).

Although the sports games are classified based on various criteria, they are essentially similar in that two teams try to get a number of points - as great as possible - by means of a specific device (ball, puck etc.). Consequently, the strength development methods are broadly similar in all sports games.

In physics, strength or force represents “the quantity of power exerted by an object on another object” (Cristea, 1980). Mathematically, it can be expressed as follows:

$$F = m \times a = \text{kg} \times \text{m/s}^2 = 1\text{N (Newton)}$$

Force is directly proportional to the mass of the object it is applied on and to the acceleration imprinted to that object. As a result, it can be increased by increasing the mass, the acceleration or both of them. Another aspect that can influence the force dimension is the angle it is applied on the respective object.

2. Generalities about strength as a motor capacity

In physical education and sports field, strength represents “man’s capacity of overcoming or resisting to a weight, as a consequence of his muscular activity” (Platonov, 2004).

Strength as a motor capacity is influenced by a series of biological and psychological factors that have an impact upon the development possibilities and the performing of motor acts specific to different sports games. M. Pradet (2000) mentions three categories of factors influencing the muscular contraction and the resulted motion:

- morphological factors – length of the bone levers, tendon orientation as compared to the bone lever, the joint angle;
- muscle internal factors – muscle cross section, percentage composition of the quick and slow fibers, muscle cell capacity of energetic output;
- neuromuscular factors – spatial and temporal recruitment of the motor units, intra- and intermuscular coordination.

Together with these factors, we also mention the development level of other motor qualities, the psychical factors (motivation, emotional states, will and attention focusing), as well as the athlete’s technical qualities (C. Hantău, 2000).

According to Platonov (1996), the strength manifestation forms are: maximum strength, explosive strength and strength under resistance conditions.

Maximum strength represents the greatest expression of force the individual is able to develop. Its level is given by the resistance the athlete can overcome or neutralize, by voluntarily and completely mobilizing his neuromuscular system. This type of strength shouldn’t be confused with the absolute strength, which refers to the neuromuscular system stored possibilities. As proved by different scientific researches, these possibilities can’t be fully expressed under the maximum stimulation conditions, but only under the action of some special external stimuli (electro-stimulation, dangerous situations etc.).

Through their specificity, sports games don’t require the use of maximum strength, but of the power, which is an optimum combination between strength and performance speed. However, the maximum strength development is necessary to get outstanding performance on the line of the two other strength manifestation forms.

Explosive strength represents the neuromuscular system capacity of mobilizing the functional potential, in order to reach increased values in the shortest time. In sports games, this type of strength has an extremely important influence on the level of performance.

When strength producing is against some increased external resistance, it is called explosive, and this kind of manifestation is important for jumping, for short-distance sprints etc. When strength producing is against some reduced or average external resistance, it is called initial (volleyball smashes, handball throws etc.).

The explosive strength manifestation is conditioned by a series of factors, such as: the maximum strength level, the muscular fiber contraction speed, the motor nervous drive power,

the muscular fiber thickness, the intermuscular coordination and the capacity of focusing one's attention.

Between the maximum and the explosive strength levels, there is a positive correlation only if the effort intensity is greater than 25% out of the maximum strength. In the efforts that suppose the overcoming of a very small resistance (hitting the volley ball), a maximum strength increased level is not necessary. In such cases the correlation between these two types of strengths is negative (Platonov, 2004).

The workouts that aim at increasing the muscle cross section, the intra- and intermuscular coordination determine a positive influence of the maximum strength over the explosive one.

Strength under resistance conditions represents the capacity of maintaining the strength parameters for an as long as possible period.

It is to mention that in sports games, these types of strength are not separately expressed, but are rather expressed through a complex interaction, which depends on each sport's discipline specificity, on the athlete's technical-tactical knowledge and on the development level of other motor capacities. The ratio between the different strength manifestation forms is also very important. From this point of view, we believe that sports games require a good development of the maximum and explosive strengths, while the strength under resistance conditions has to be developed to such a level, as to sustain the two other forms in the game course. During the training and competition, strength parameters are expressed through muscular contractions of the following types:

- isotonic (dynamic) – the muscles don't modify only their tension, but also their length;
- isometric (static) – the muscles don't modify their length, but only the tension state;
- auxotonic – both the muscle length and the intramuscular tension are modified.

Because in sports games there are no isometric effort moments, we think that the isometric training method is not efficient for this group of sports disciplines.

3. Strength development stages

Strength development processes are closely related to man's development phases, among which we mention: the pre-puberty phase (8 to 12 years old), the puberty phase (12 to 16 years old), the post-puberty phase or adolescence (16 to 21 years old) and the maturity phase (over the age of 21) (Cerretelli, 2001).

Explosive strength training may start at the age of 7 or 8 years, both in girls and boys, with an emphasis on the speed component.

General muscular development may start at the age of 9 to 11 years (girls and boys). Starting with the age of 11 to 13 years (girls) and 12 to 14 years (boys), it is possible to stress the explosive strength development and the general muscular development. The training for intramuscular coordination and for strength under resistance conditions starts at the age of 13 to 15 years (girls) and 14 to 16 years (boys), because the stress on these objectives could be applied at the ages 14 to 16 years (girls) and 16 to 17 years (boys). Power training may start at 17 years old and the maximum strength training, over the age of 18 (Bompa, 2001). (table 1)

4. Strength training types and methods

In the activity of training the different strength manifestation forms, the methodical succession is the following:

- in the first phase – muscular development;
- in the second phase – intramuscular coordination improvement through the “combined” training;
- in the third phase – explosive strength development amplified with intramuscular coordination.

Other rules for the strength training organization, mainly when using loads, are the following:

- the training must start with a warm-up, mainly targeting the muscular groups that will be exerted during the effort;
- the training loads have to be diversified, in order to avoid muscular imbalance;
- it is important to keep to the principle of load graduation;
- the performed movement should be correct from a technical point of view;
- the recovery intervals must be established in relation to the settled intensity and objective;
- after long training breaks, the effort must be progressively increased;
- in case of exhaustion, the great intensity efforts must be avoided.

A. Maximum strength training

Maximum strength training has two main objectives: muscular development (hypertrophy) and intramuscular coordination development.

a. Muscular development training

This type of training represents the most frequently used method to increase maximum strength, its main objective being to increase the muscle cross section; it is also called “the method of submaximal efforts repeated to the utmost”. The muscle constitutive elements aimed by this method are: an amplified recruiting of the active units, the intra- and intermuscular coordination, an increased exertion of the intramuscular energetic stores, the progressive adaptation of all the muscle and joint passive structures.

Intensity	60 – 80%
Repetitions	8 – 12
Movement speed	constant, slow, with no interruptions
Series	3 – 5
Break	3 minutes

The disadvantages of this method are: the accumulated fatigue has a negative effect on the neuromuscular transmission quality, it is energy consuming, the maximum strength development has a slow evolution and the muscular mass exaggerated increase negatively affects mobility. That is why muscular stretching exercises are prescribed when using this method.

b. Intramuscular coordination training

This type of training results in the quick and strong increase of maximum strength, but without inducing a muscular hypertrophy. In order to fulfill this objective, it is prescribed to use the method of maximal and supramaximal efforts, these ones representing 90 to 110% out of the maximum possibilities. Muscular contractions are concentric in maximal efforts and eccentric in supramaximal efforts. This method efficiency comes from the quality of the generated

neuromuscular excitations and from the exertion of neuromuscular units, especially at the rapid fiber level.

Intensity	90 – 110 %
Repetitions	1 – 5
Movement speed	slow - rapid (depending on the effort intensity)
Series	6 – 7
Breaks between series	2 – 3 minutes

The disadvantages of this method are: a weak influence on the muscular volume, the intermuscular coordination limiting, very great efforts at the CNS, joint, ligament and tendon levels, as well as the fact it can't be applied to beginners and to young people under 21.

c. Combined training

This training type relies on the combination of the two possibilities for the maximum strength increase, namely the muscular hypertrophy and the intramuscular coordination improvement. For the muscular hypertrophy it is necessary to perform an increased number of repetitions (the stimulus great duration), while for the maximum strength development based on the intramuscular coordination improvement, the number of repetitions is reduced. (table 2) Consequently, in the combined training the number of repetitions and the effort intensity have a pyramid or a double pyramid variation:

pyramid	5 x 75%; 4 x 80%; 3 x 85%; 2 x 90%; 1 x 95%
double pyramid	4 x 80%, 3 x 85%; 2 x 90%; 1 x 95%; 1 x 95%; 2 x 90%; 3 x 85%; 4 x 80%

B. Explosive strength training

The main objective of the explosive strength training is the development of the contraction speed in those muscular groups important for the efficiency increase in sports games. In order to train the explosive strength, the following succession of objectives has to be adopted:

- maximal strength development;
- explosive strength training adapted to each sports game specificity, partially to regain the contraction speed or to increase it.

A methodical approach with very good results is the following: an explosive strength training after a combined training for the maximum strength development. (table 3)

Another method for the explosive strength development is the reactive load method (plyometric training), which relies on the muscular fiber stretching - shortening cycle.

The explosive strength development through this method is conditioned, in a 54% ratio, by the maximum strength development (Harre, 1986). Some authors (Harre, 1994) call it elastic or reactive strength and consider it as being an independent quality that can be trained by using reduced loads.

This quick stretching - shortening cycle leads to some tension forms almost similar to those reached during the competition. The plyometric method is based on high or depth jumps, the height of the depth jumps corresponding to the greatest height reached while performing the high jump.

This method is applied by keeping to the following norms:

- training will be performed only under rest conditions and after a proper warm-up;
- perform 5 to 8 repetitions for each series, 3 to 5 series;

- the minimum break after a series is 2 minutes;
- it is counter-indicated to those with muscular damages;
- it is practiced twice a week at most;
- for the trained athletes, the work heights are comprised between 70 and 110 cm, while for the juniors they are comprised between 40 and 70 cm.

C. Strength training under resistance conditions

The main method to train this strength manifestation form is circuit training. The muscle activity is dynamic and the intensity is 40 to 60% out of the maximum strength. The work pace must correspond to the competition pace.

When the means are performed with workloads, duration is comprised between 30 and 150 seconds, and the break duration between 30 and 90 seconds. If this method represents a training part, the number of repetitions is 10 to 12 per workshop, and if the training is made up of this method entirely, 40 to 50 repetitions per workshop are possible (Platonov, 1996).

Intensity	40 – 60%
Repetitions	10 – 12 or 40 – 50
Workshops	6 – 12
Series	3 – 6
Break after the workshop	1 minute
Break after the series	3 – 4 minutes

5. Strength capacity evaluation

Maximum strength evaluation is particularly important, because all the efforts made while training the strength manifestation forms are expressed according to its level.

Maximum strength can be evaluated as follows: for instance, if we want to evaluate the biceps maximum strength for the flexion motion of the forearm on the arm, the device specific to this motion is loaded with a certain weight and the repetitions performed by the athlete are counted. If the number of repetitions is comprised between 2 and 9, the used formula is:

$$\text{Max. strength} = \frac{\text{nr. kg}}{1,0278 - (\text{nr repeti\c{t}i} \times 0,0278)},$$

and if the athlete performs more than 9 repetitions, the data from the table 4 are used.

To evaluate the explosive strength in the lower limbs, it is possible to use: the Sargent test, the long jump from the standing position, the Abalakov test, the Squat Jump test, the Margaria test. Explosive strength can also be indirectly tested, by measuring the time necessary for an athlete to perform a movement specific to his discipline, against a precisely defined load.

6. Strength training planning and programming

In sports games, the yearly planning is generally made up of two cycles, each one composed of three periods. In exceptional cases, for the top athletes, the planning is made up of three cycles. A cycle includes a preparatory period, a competition period and a transition period.

The method of submaximal efforts mobilized by a maximum number of times is programmed in the preparatory period. The general physical training part (its importance diminishing as we get closer to the more specific training periods and to the competition period) is not used at all any more (table 5).

The method of maximal and supramaximal efforts will be used in the periods of passage from the general to the guided training. It is possible to use two such workouts a week, at most, but with some days in between, in order to allow the body to recover.

The combined training method is used in the special training period to maintain the maximum strength level, but only once a week. The plyometric training method is introduced during the guided training period and in the special training period. The circuit training method is introduced during the guided and the special training periods.

Through the following program, we shall demonstrate the strength training within a complete cycle for seniors:

Preparatory period – 9 weeks

- *engagement microcycle* (1 week) – average intensity and great volume, work for the great muscular groups;
- *main subperiod* (of general training – 5 weeks) – volume and intensity increase, maximum strength development and - starting with the third week - work for the explosive strength development;
- *transformation subperiod* (3 weeks) – means guided towards explosive strength and strength under resistance conditions, a weekly training for the maximum strength maintaining.

Competition period – 12 weeks

- reduced volume and same intensity;
- the used methods are: plyometrics, circuit training and the combined method.

Transition period – 4 weeks

- reduced volume and intensity, and, in the second part, introduction of means for the muscular development.

7. Conclusions

Physical training, in general, and strength training, in particular, are essential elements of modern training. Among the training factors (technical, tactical, physical, psychological etc. preparation), the only one that is present in all the training cycle periods is physical training.

The aim of strength training is not only to increase the athlete's general strength indices, but also to increase his capacity of using these indices when competing, in harmony with the players' technical-tactical requirements. This harmony is necessary if we expect strength to have a significant influence on the results.

Table 1 – Training forms and strength manifestations at different ages

Training forms and forms of strength	Age	
	girls	boys
General muscular development	7 – 8	7 – 8
Stressing the explosive strength training and the muscular development	9 – 11	9 – 11
Initiation training for the intramuscular coordination and the strength under resistance conditions	11 – 13	12 – 14
Stressing the training for intramuscular coordination and strength under resistance conditions	14 – 16	16 – 17
Power	17 –	17 –
Maximum strength	18 –	18 –

Table 2 – Intensities, repetitions and number of series in the maximal strength training

Training	Intensity	Repetitions	Series
Training for hypertrophy	60 – 80%	8 – 12	3 – 5
Training for intramuscular coordination	90 – 110%	1 – 5	6 – 7
Combined training	60 – 100%	1 – 8	3 – 5

Table 3 – Training for the explosive strength development combined with a training for the maximum strength development

Day	Monday	Thursday
Intensity	8 x 60%; 6 x 70%; 4 x 80%; 2 x 90%; 1 x 100%	30%
Repetitions	-	10
Series	2	4
Execution speed	constant, uniform	explosive – contraction slow – relaxation
Break between series	4 minutes	5 minutes

Table 4 – Maximum strength equalization with the number of repetitions

% Maximum strength	Nb. of repetitions
80	11
75	16
70	22
65	25
60	30
55	35

Table 5 – Strength training organization within a cycle

Level	Training period	Competition period	Transition period
Beginners	General strength		General strength
		Guided strength	
Advanced	General strength		General strength
		Guided strength	
		Special strength	
Seniors	General strength		General strength
		Guided strength	
		Special strength	

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