

DEVELOPMENT OF STRENGTH IN PHYSICAL CONDITIONING

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A simple outline of recommended principles and procedures applied to general and specific strength development with tables of some typical loads and workout frequencies for different performance level athletes. The article is a slightly abbreviated translation from Teoriya i Praktika Fizicheskoi Kultury (Russia)

INTRODUCTION

The purpose of general physical conditioning is to develop and strengthen the athlete's body as the whole, to increase the functional potential of the organs and systems, to develop motor musculature, to improve coordination and to increase strength, speed, endurance, agility and flexibility to the desired levels expected for top performances in a certain sporting activity.

These objectives are achieved by using a wide range of exercises, in particular general conditioning exercises. However, even in the employment of general conditioning exercises, coaches are advised to choose exercises by closely considering the peculiarities and demands of an athlete's specific competition event. For example, endurance athletes require less strength development exercises than athletes in throwing events. On the other hand, there are a large number of sports where a balance is needed in the physical capacities in order to succeed.

SPECIFIC PHYSICAL PREPARATION

An athlete's specific physical preparation should consist of exercises that align with the competition event as closely as possible. This similarity should include the range of movements, the nature of movements, the muscular effort, the cardiovascular load and the psychological stress of a single element of the event or the event in its entirety. This principle was introduced some time ago by Nikolai Ozolin and is called the "principle of applicability". It has since been corroborated in many scientific studies.

For the most part, general, non-specific exercises are employed in the general physical conditioning phase. Conversely, narrowly focused exercises are used in the specific physical preparation phase. However, it is common to make use of localized specific exercises in the general physical conditioning phase to eliminate certain physical deficiencies.

As athletes mature and improve their technical skills, the number of general physical conditioning exercises diminishes. At this stage general physical training exercises are replaced by specific exercises that help to develop the athlete's event specific physical capacities.

It should be noted here that the volume of general physical training exercises in the training system depends largely on the athlete's physical condition level. If an athlete has shortcomings in specific muscle groups, has poor mobility or poor cardiovascular or respiratory work capacity, he/she should make use of the appropriate types of general physical exercises.

The amount of time devoted to general physical preparations in training varies considerably and depends largely on the demands of the athlete's competition specialty. In case of endurance type of events, little time is spent on general physical training since most (as much as 85%) of the total training time is devoted on the development of endurance (running). A careless choice of general conditioning exercises would here not only waste valuable training time, but can also produce negative results.

A typical example would be to look at today's jumpers in track and field. They execute 2000 to 3000 full approach jumps a year, spending 4 to 6 hours a week to execute these jumps. They also employ a heavy volume of a variety of jumping and bounding exercises, weight resistance exercises, flexibility exercises and exercises for specific muscle groups.

As an athlete's technical skills improve, the general physical conditioning training means gradually change to maintenance or the improvement of certain elements of physical fitness that are common to all athletes. Specifically, these elements include mainly cardiovascular and respiratory capacities and metabolic processes. Continuous running and cross-country skiing are common training means to develop the functional capacity of these systems. Keep also in mind that when an athlete's functional potential improves, he/she can increase the volume of specific training and improve the recovery capacity.

Some athletes need to make use of preventive and corrective exercises to overcome shortcomings in posture and to strengthen muscles that are not heavily used in the competition specialty, but can lead to technical faults. The same principle also applies to the elastic properties of muscles.

The general exercises employed by athletes to develop their functional potential are vitally important. For example, it is strongly recommended to use flexibility exercises between weight resistance exercises, as well as general exercises and other type of sports during the recovery or taper-off phases of training. This allows providing essential work to the muscular system and rest to the nervous system. Such activities are also used during the active rest phase.

However, it is important to keep in mind that when a coach makes use of a variety of exercises and other sports for general physical training, he/she should know precisely the objectives to be achieved. As already mentioned, a careless choice of general exercises can be responsible for negative results.

STRENGTH DEVELOPMENT

Most athletes need strength, in particular explosive strength. The development of an athlete's strength requires:

- An improved neuro-muscular co-ordination.
- An improved capacity to exert forceful efforts.
- A larger muscle mass.

Other factors that play a significant role in muscular strength are blood supply to the muscles, metabolic processes and energy reserves.

Most athletes use strength exercises continuously, employing exercises with variable resistances to develop their neuro-muscular co-ordination in power movements. The development of a high power output takes place in the use of heavy and maximal resistance exercises. To increase the muscle mass, athletes work with high repetitions to the stage where fatigue begins to interfere with proper technique. This exhaustive method is also used to strengthen ligaments and joint-ligament structures.

Athletes develop specific strength by employing exercises that imitate as closely as possible the nature and structure of their specific event movements or their components. In contrast, general strength is usually developed by employing exercises that vary widely in the amount of co-ordination and effort they require. General strength comes from the use of a variety of exercises that range from elementary movements to the performance of the complete movement structure of the competitive event against resistance.

The most important exercises use the following resistances:

- Weights: dumbbells (from 2.5kg); sandbags (up to 15kg); medicine balls (2 to 5kg); weight belts (5 to 60k); weight vests (up to 10kg); wrist weights (1 to 2kg); kettlebells and barbells (16 to 32kg);
- Jumps: athlete's own body weight in bounding, multiple jump and squats.

Additional exercises include using a partner to provide resistance, various training devices of pendulum, swing, or centrifugal type, isometric exercises

against immovable resistance and depth jumps followed by an immediate rebound.

Weight resistance exercises deserve special attention. Let us look at the following examples that do not greatly alter the movement structure of the competition event and therefore makes it possible for the athlete to develop strength under conditions that closely approximate the “real” action:

- Throwing heavier than normal implements.
- Jumping exercises with additional weight on the shoulders.
- Jumping exercises with a weight vest or ankle weights.
- Running exercises with a weight vest, ankle weights, or heavy shoes.

Scientific studies have indicated that the use of heavier than normal conditions in jumping, throwing and running exercises will definitely assist in the development of explosive strength above the level achieved with exercises without additional resistance. However, it has been recommended that the volume of extra resistance exercises should not exceed 20 to 25% of the volume of the same exercises performed without extra resistance.

Athletes should always alternate between extra resistance and regular resistance exercises within a single training session, as well as between neighboring workouts. Dynamic exercises should be performed by shifting gradually from slow to faster movements and from easy to harder movements. As the athletes advance, priority can be given to exercises that are performed at maximal speed. Maximal static contractions are naturally applied to isometric exercises that set heavy demands on the nervous centre thus expanding their functional potential.

Strength development exercises are used relatively more during the preparation period and less during the competition phase. However, specific strength development exercises, which often require maximal exertion, continue to be employed during the competition period. This is not only for the maintenance of the strength level but also to further increase the achieved strength level.

The primary strength development exercises are used three times a week because of the heavy, intense effort involved. On the other hand, lighter exercises can be used virtually in every workout. The increased strength level of individual muscle groups can be successfully exploited in all types of events only through a highly coordinated neuro-muscular activity. The last can be improved by performing the movement in its entirety.

To conclude, we have presented tables that reflect the typical level of resistance and recommended load dosages for a series of exercises. The recommendations are made to three different performance levels — minimally trained, moderately

trained and well trained athletes. The suggested dosages include the recommended number of repetitions and sets to be performed and the number of weekly workouts.

EXERCISE	MINIMALLY TRAINED	MODERATELY TRAINED	WELL TRAINED	NO. REPS	NO. SETS	WORKOUTS PER WEEK
Barbell clean	80-100% of body weight	80-100% of body weight	100-200% of body weight	1	5-6	2-3
Barbell snatch	60-70% of body weight	80-110% of body weight	120-130% of body weight	1	5-6	3
Bench press	80-100kg	100-180kg	120-240kg	1-2	5-6	3
Back squats	80-100kg	100-150kg	160-270kg	2-3	3-8	2-3
Leg press (lying supine)	90-110kg	120-170kg	180-280kg	2-3	4-6	2-3

TABLE 1: Typical resistances and loads in basic weight training exercises

EXERCISE	MINIMALLY TRAINED	MODERATELY TRAINED	WELL TRAINED	NO. REPS	NO. SETS	WORKOUTS PER WEEK
Split jumps with barbell on shoulders	20-30% of body weight	40-50% of body weight	50-60% of body weight	10-30	2-3	3
Circular trunk bends and turns with barbell	10-15kg	20-30kg	30-60kg	3-6	1-3	3
Swinging weights	5 x each side	10 x each side	10 x each side	-	5-6	3
Dumbbell straddled bench jumps	16kg	32kg	32kg	10-15	3-5	3
One legged squats on each leg	-	-	-	To exhaustion	2-3	3

TABLE 2: Typical resistances and loads in other weight training exercises (selected examples)

EXERCISE	MINIMALLY TRAINED	MODERATELY TRAINED	WELL TRAINED	NO. REPS	NO. SETS	WORKOUTS PER WEEK
Walking while carrying a partner	10-20m	20-30m	40-60m	-	2-5	1
Running while carrying a partner	10-20m	20-30m	30-50m	-	2-3	1
Double legged multiple jumps	1 min	3 min	5 min	-	10-15	5-6
Knee lifts with weights, standing on one leg	10kg	15kg	20kg	To exhaustion	2-3	3
Upstairs or uphill jumping exercises	-	-	-	To exhaustion	2-5	2-3
Depth jumps (60-90cm) with horizontal or vertical rebounds	-	-	-	10-20	1	4-5
Isometric exercises	5-6 sec.	6-8 sec	6-8 sec.	6-8 sec.	2-4	3

TABLE 3: Typical resistances and loads in a variety of randomly selected strength development exercises