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STRENGTH TRAINING

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SUMMARY

This text discusses the current knowledge about the effects of strength training from both theoretical and practical viewpoints. For optimal performance, a basic understanding of the effects of strength training on the neuromuscular system is useful. The practical applications of strength training are also discussed and practical advice given on training programs.

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TAKE-HOME MESSAGES:

- Strength training induces adaptive changes in both muscle morphology and neuromuscular function.
- In general, the type and mode of exercise dictate the training outcome. Heavy resistance training not only increase muscle mass but also evoke marked increases in muscle power and contractile rate of force development.
- Women and men respond to strength training in very similar ways in terms of their individual pre-training baselines.

INTRODUCTION

The positive effects of strength training demonstrated in a large number of scientific studies have made this type of exercise an essential part of the training in many sports disciplines. Previously, strength training was primarily used in sports requiring overt strength, such as weightlifting and athletics. However, with the increased understanding of the benefits of this type of training, its usefulness has been recognised for a wide variety of sports in which muscle strength, speed and jump power are important for performance.

Also, new research has shown that strength training is important in preventing muscle strains, which are prevalent in many types of sports where explosive muscle actions are involved, for example, football, tennis, and track and field. Moreover, strength training has been shown effective in preventing ligament injuries by increasing the strength of the muscles surrounding a joint and thereby increasing joint stability. In particular, this training has proven effective in counteracting cruciate ligament injuries of the knee, which are highly prevalent in female athletes. Furthermore, strength training is a key factor in rehabilitation after muscle, tendon and bone injuries. Thus, as already occurs in men's sports, strength training can be included to great advantage in training regimens for women in many types of sports.

ADAPTATIONS TO STRENGTH TRAINING

Strength training not only has positive effects on muscle tissue, but also greatly affects the nervous system, connective tissue, tendons and bones. The initial physiological changes that are experienced after a short period of strength training (within weeks) are, however, primarily due to improvements (adaptations) in the neuromuscular system. Thus, positive adaptations occur within the muscle tissue itself, but surprisingly, strength training also induces significant changes in the nervous system, especially when the training is performed at a particular intensity. This form of training is normally referred to as 'heavy strength training'. The meaning of heavy strength training and how the training outcome is affected by different load intensities will be explained later in this text.

The structure of muscle tissue

Skeletal muscle is a fascinating, plastic tissue that represents the largest 'organ' of the body and makes up approximately 40% of the total bodyweight. In total, there are around 300 individual muscles in the human body. Each muscle is composed of a large number of muscle cells called muscle fibres, arranged in parallel. Each muscle fibre is surrounded by a membrane of connective tissue that forms a network and eventually fuses and becomes continuous with the tendons of the muscle. Apart from maintaining the specific pattern of the skeletal muscle tissue, the connective tissue also plays an important role in the transmission of force from the muscle fibres to the tendons and bone.

Muscle fibre types

Simply put, skeletal muscles are composed of two main types of muscle fibres, which have different contractile properties (Figure 1). Type I fibres are primarily characterised by a slow contraction speed and excellent endurance capacity. Type II fibres are further subdivided into type IIa and type IIX. In general, however, type II fibres are characterised by a fast contraction speed and the ability to produce a higher muscle force relative to muscle cross-sectional area (specific force) compared to that produced by type I muscle fibres. Moreover, type II fibres can develop high force rapidly (i.e. rate of force development, or rFD), as well as high power, but generally have less endurance capacity. The main difference between type IIa and IIX fibres is that type IIa fibres have more endurance capacity and a slightly lower peak force compared to IIx fibres. Therefore, muscles with a majority of type I fibres have great endurance capacity, whereas muscles with a majority of type II fibres are faster and able to rapidly develop high contraction force.

The distribution of fibre types varies between individual muscles in both the upper and lower extremities. Depending on the purpose of the muscle, some muscles are dominated by mainly type I fibres (e.g. the soleus muscle), whereas others are dominated by type II fibres (e.g. the triceps brachii muscle). There is also considerable individual variation in muscle composition, which is genetically determined. Thus, individuals with a high proportion of type II fibres may have an advantage in sports characterised by explosive actions of short duration. Similarly, individuals with a high proportion of type I fibres may have an advantage in sports that require great endurance capacity.

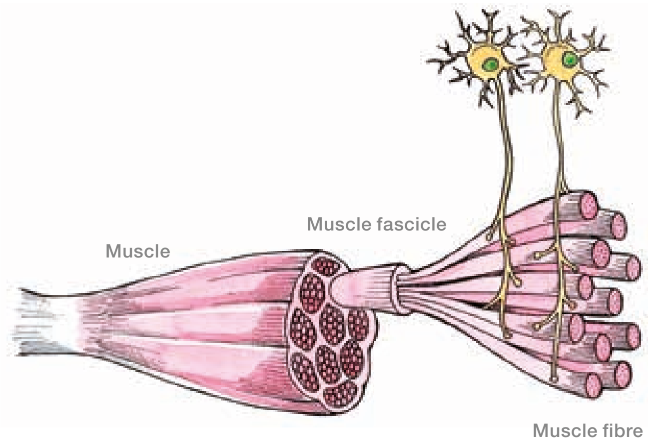

Figure 1. Muscle structure. Muscles are composed of many fibres (muscle cells) aligned longitudinally in the muscle. There are two basic types of fibres, type I and type II.)

Muscular adaptations to strength training

The most noticeable effect of strength training, apart from the increase in muscle strength, is an increase in muscle size. This increase in muscle size, termed 'hypertrophy', is partly due to an increased cross-sectional area of individual muscle fibres, and partly due to architectural changes/adaptations (steeper pennation angles of the individual muscle fibres) that contribute to the increased cross-sectional area of the muscle as a whole. The major advantage of a larger muscle cross-sectional area is an increase in contractile muscle strength, since a strong relationship has been found between the cross-sectional area of a given muscle and the force it can develop. Notably, muscle fibre hypertrophy does not seem to occur to the same extent in type I and type II fibres and it seems evident that type II fibres are characterised by a larger potential for hypertrophy than type I fibres.

Thus, an individual's potential for muscle hypertrophy may be largely influenced by their individual fibre type composition. These variations in fibre type composition may also explain to a large degree the significant individual variations in the degree and speed of response to strength training. However, if a person new to strength training works out for a couple of months, typically the muscle fibres gradually enlarge and the muscle becomes larger overall.

The fact that the size of the fast-contracting type ii fibres increases more with strength training means that a larger part of the cross-sectional area of a given muscle will then be occupied by type ii muscle fibres. This proportional change in fibre-type composition increases the power output per cross-sectional area, which means that strength training not only makes a muscle bigger but also leads to qualitative changes. That is, the muscle can perform more work at a given contraction speed and the contraction becomes more explosive (increased rate of force and power development). The importance of the above in a sports-related context will be further examined later in this text.

In many sports, for example, gymnastics, long-distance running, ice skating, cycling, triathlon and, not least, in disciplines with weight classes (rowing, tae-kwan-do, karate), a low bodyweight is advantageous. Therefore, at first glance, strength training may seem a disadvantage because of the potential weight increase due to muscle hypertrophy. Importantly, however, muscle strength can be increased without muscle hypertrophy, but this demands a specific form of strength training where the primary focus is to achieve benefits through adaptations in the neural system. We will discuss this form of training in more detail below.

Neural control of muscle contractions

The motor centre in the brain has overall control of muscle contractions and, therefore, the movement of the body. From this centre, signals travel down the motor nerves in the spinal cord and out to the muscles via motor nerve fibres (Figure 2). Even the smallest or most insignificant movement is preceded by a long chain of nerve signals from the brain to the muscles. Notably, some of the elements of this chain can be developed with specific strength training.

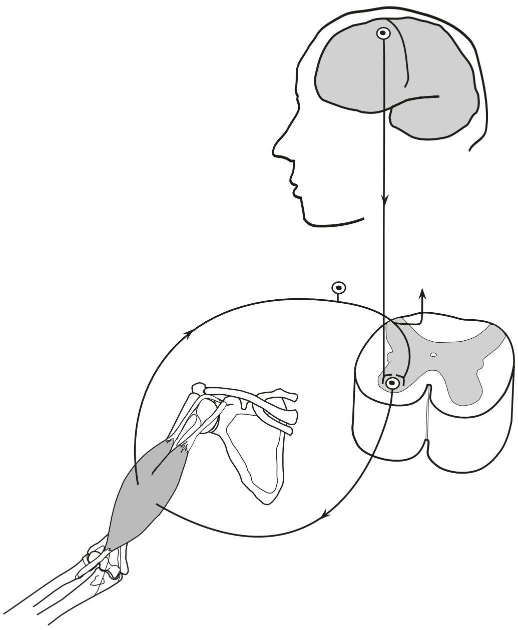

Figure 2. The control of muscular movements by the nervous system. Signals from the motor centre in the brain travel down the spinal cord. Motor nerve fibres exit the spinal cord and carry the signals to the muscles, which stimulates contraction of the muscles.

Neural adaptations to strength training

Strength performance is determined not only by the size of the involved muscles, but also by the ability of the nervous system to appropriately activate the muscles. The significant early improvement observed in muscle strength after only a few weeks of strength training (without an increase in muscle size) is therefore mostly due to a positive influence on the nervous system. These effects include better muscle coordination and increased muscle activation. Both the number and the speed of nerve signals to individual muscle fibres increases, that is, the neural activation of muscle fibres is improved (also called increased 'neural drive'). This increased activation improves maximum muscle strength without the muscle mass necessarily enlarging—improving the quality of the muscle contraction. In addition, increased neural drive means that explosive muscular strength (rate of force development, RFD) improves, so that high contractile muscle strength is achieved within a fraction of a second. This parameter of strength is highly important in many different sports disciplines in which movements must be performed within a split second.

Therefore, the more contractile muscle strength that can be developed within the first 0.1–0.2 seconds of a muscle contraction—typically the amount of time that elapses when the foot has ground contact in connection with a jump, or in other types of movements like throwing or kicking a ball—this is highly advantageous to the athlete. As mentioned earlier, the neural adaptations begin within the first weeks to months after starting strength training, whereas muscular changes often appear later (2-3 months after beginning training). Thus, the neural adaptations predominantly account for the increase in strength in the first weeks of strength training. The most striking improvements are seen in relatively inactive individuals and in athletes who have not previously engaged particularly in strength training, especially with heavy weight loads. These groups can potentially show great improvements in neuromuscular control and, therefore, in maximal muscle strength and explosive muscle strength, without necessarily inducing muscle hypertrophy.

WOMEN AND STRENGTH TRAINING

Women generally have smaller bodies, have less absolute muscle mass and display approximately two-thirds of the overall muscle strength of men. However, women and men respond to strength training in very similar ways when their individual pre- training baselines are considered, and most studies suggest men and women can achieve similar relative results with strength training. This is most noticeable with the improvements observed within the first months of training in individuals who have not previously performed strength training. These findings are further supported by the fact that men and women do not differ in how training and the intake of protein around the time of exercise affect protein synthesis.

Furthermore, there is generally no evidence to support any difference in the specific strength (contractile strength per unit cross-sectional area) of the muscle tissue in men and women. That is, any differences are not determined by sex, but can primarily be ascribed to differences in fitness levels. In other words, men and women who have muscle tissue of similar fibre composition and who exercise at the same level can generate the same contractile muscle strength per unit area of tissue. As noted above, neuromuscular control is a decisive factor in power production, and its influence appears similar in women and men when the results are expressed relative to muscle mass. Thus, sex does not affect the neural adaptations possible through strength training.

Despite the lack of significant sex differences in most of the exercise adaptations achieved through strength training in the initial phase, women do not have the same hormonal predisposition to increase their muscle mass and muscle strength in the long term as do men. The blood level of the hormone testosterone, a significant stimulator of muscle growth, is about twenty times higher in men than in women. The great individual variation in the amount and speed of response to strength training is, in addition to genetic variation in fibre composition, partially explained by the circulating level of testosterone. This fact is supported by a study of young women that found a close relationship between the women's blood level of testosterone and their muscle growth after 16 weeks of heavy weight training.

However, the similarity in muscle growth achieved by men and women in the initial phase of a strength training program also reflects other import factors that control growth during the first 3–6 months of a program. One of these factors may be the local influence of a muscle-specific growth hormone (mechano-growth factor, MgF); the tissue levels of MGF have been shown to rise in both men and women during strength training. However, recent research data indicates that the tendon tissue of women may not have the same potential to adapt to training as that of men, and that oral contraception can increase this sex difference.

STRENGTH TRAINING IN DIFFERENT SPORTS DISCIPLINES

Strength training is a natural part of the training regimen in strength-dominated sports disciplines such as athletics (e.g. sprint, javelin and discus), weight lifting and rugby. However, it has clearly been shown that many other sports disciplines can use strength training to great advantage as well. Strength training is very beneficial for athletes performing ball sports (e.g. volleyball, basketball, football, handball), and even in more endurance-related sports disciplines such as triathlon, cycling, skiing and medium-distance running increased strength is often beneficial.

As mentioned, the maximum power a muscle can produce primarily depends on two factors: the muscle's size (cross-sectional area per unit volume) and how effectively the muscle fibres are activated by the nervous system. Depending on the organisation of the workout schedule, these qualities can be trained either together or independently of each other. Therefore, strength training can be targeted very specifically towards the particular qualities one wishes to improve. In many sports, improving both factors is advantageous, while others may require focus on only one of the factors. A general discussion follows about the benefits of strength training for different sports disciplines. For more specific advice, readers should consult further literature in their field.

Ball sports

Large differences exist both in the demands on the players among the various ball sports and in the demands on individual players within a particular sport. Despite these differences, most ball games commonly involve jumping and rapid accelerations. These abilities can typically be improved by strength training, and ball players whose performance depends on high jumps and powerful accelerations (e.g. handball, volleyball, basketball, football) can benefit immensely from heavy (explosive) strength training, where the focus is on increasing the neural drive to the muscles. Some players will also profit from generally increasing their muscle mass and can periodically use moderate to heavy strength training to stimulate muscle hypertrophy. For example, defence players in the more physically challenging ball sports such as handball and football can benefit greatly from increased maximal strength through training for increased muscle mass, as well as training for neural adaptation.

This fact becomes very clear when comparing the weight and body composition of current elite handball players of corresponding players from the 1980s and 1990s and clearly shows that strength training has been highly incorporated in the training regimens of this sport discipline. In general, the muscle mass of female and male handball players has increased by an average of about 5 kg and 10 kg, respectively, during the past 20 years. For other types of ball players, for example, offensive players in football, weight gain is not necessarily desirable, and therefore strength training may instead be directed towards improving neural activation and the hypertrophy of tendon tissue to prevent overload injuries.

These marked differences between ball players and the demands placed on them in their various sports make it difficult to give general advice. Ideally, the needs of each athlete are individually evaluated to formulate a specific training regimen based on training status and performance demands. In general, however, goal-oriented strength training contributes to reducing the number of muscle injuries and, possibly, knee injuries. The latter is especially true for female athletes, who have a markedly higher risk of knee injuries (e.g. tearing of the anterior cruciate ligament) than that of their male counterparts. This increased risk is partly due to lower strength (relative to the strength of the quadriceps muscle) of the hamstring muscles. For injury prevention, therefore, ball players should preferably include strength training in their daily regimen, in particular, strengthening of the hamstring muscles.

Endurance sports and strength training

In the past, strength training and endurance sports were seen as incompatible, and only recently has strength training been given a place in these sports disciplines. The physiological stimuli produced by strength training and endurance training largely act in contradictory ways on muscle tissue. However, newer research has shown that a connection between increased muscle strength and improved endurance is possible. A part of the explanation for the improved endurance seen after strength training may be the more efficient utilisation of the endurance adapted type I fibres, thereby reducing fatigue in the muscles at the same relative workload. Another part of the explanation may lie in the ability of strength training to transform type IIX muscle fibres into the more endurance-resistant type IIa fibres. These factors may explain why strength training incorporated into training for long-distance running leads to better running economy, that is, the ability to run more efficiently for a longer time.

As an increase in bodyweight are usually undesirable in endurance sports, the strength training undertaken should aim at increasing muscle strength without increasing muscle mass or total bodyweight. Therefore, the training regime should be specifically directed at improving neuromuscular control, in the form of increased neural drive.

STRENGTH TRAINING IN PRACTICE

Strength training is most often defined through the principle of overload. In practice, this means that, in a safe, controlled environment, the muscles are exposed to an external resistance that is larger than the usual resistance to which they are exposed. This increased resistance acts as a stimulus to increase muscle strength, which is expressed through a series of changes in the neuromuscular system.

In practical terms, the external resistance applied needs to be of a particular intensity to trigger the physiological changes, and the training is therefore preferably performed at specific weight loads using strength training machines or free weights. In addition to application of the overload principle, some further fundamental components are required of strength training, programs can be designed in potentially limitless ways, depending on which aspects one wishes to focus.

Progression

One of the challenges of strength training is to incorporate progression in a safe and systematic way that increases the external resistance in parallel with the development of strength in the muscle(s). The opposite challenge is to avoid stagnation or failure to achieve the desired goal. Progression can be incorporated into a training program by increasing a number of factors:

- the intensity (i.e. lifting heavier weights)
- the number of repetitions at the same intensity
- the number of sets per exercise session
- the number of exercise sessions per week.

Generally, a gradual progression is recommended; either the intensity (the weight load) or the volume (number of repetitions, sets, workouts per week) is increased. Increasing both intensity and volume together increases the risk of injury.

Specificity

The exercise effects achieved through strength training are specific to the stimulus applied to the neuromuscular system (i.e. the particular exercise(s) performed). The effects depend on various factors. For example:

- the intensity of training
- the volume of training
- the muscle groups involved
- the contraction speed
- the intervals between each set.

Taking account of these factors allows training programs to be tailored to individual athlete's needs. As mentioned previously, there are big differences between optimal training regimens for players in different sports, for example, a shot-putter and a volleyball player. Even within the same sport, the best results of strength training are achieved by focusing on the individual athlete's training status and performance needs.

Variation

Variation is an important factor to ensure continued improvements when strength training over extended periods (i.e. months or years). If the same exercises are continually performed at the same intensity and volume, most people will experience a stagnation in their progress— in terms of both muscle growth and muscle strength—after about 8–12 months of training. For continued improvement, diversifying the training through changing one or several variables must challenge the neuromuscular system.

Therefore, for long-term progression, a training regimen is 'periodised'. This typically involves periods in which either the volume or the intensity of the exercise is adjusted. Several studies have demonstrated more benefits from periodised strength training than from non-periodised training.

Measuring muscle strength

To decide the optimal exercise load for an athlete, a goal for maximum muscle strength is required, along with accurate measurement of the athlete's starting level and progression during the strength training program. Accurate measurement of progress is especially important in the early phase of training, when relatively rapid improvements in maximum muscle strength occur. As described above, if the workload it is not adjusted to match the strength improvement, the effects of training will not be optimal. Muscle strength can be measured in a number of different ways. Some methods that are very time consuming and demand expensive equipment are primarily used to test elite athletes, while others are easier to use in daily workouts. The 1 RM (one repetition maximum) principle is an especially useful tool in the daily workout and is therefore explained in more detail below.

The repetition maximum concept

One repetition maximum (1 RM) is defined as the weight a person can lift for a given exercise performed only once (i.e. 1 RM = maximum load). The RM values are an effective way to describe a given workload as either an absolute value or a value relative to maximum muscle strength. By measuring the maximum load, the weight corresponding to a particular relative load can be easily calculated. For example, 8 RM equals the weight that can be lifted a maximum of eight times, and so on.

Importantly, however, athletes are often advised not to train to absolute exhaustion, that is, to perform slightly fewer repetitions than they are capable of (e.g. at an 8 RM load, only perform six repetitions). In this way, overloading and muscle strain are avoided, especially in the early phases of training. Likewise, when the training is oriented towards neural improvements and developing explosive muscle power, or when training in technique (e.g. lifting techniques for free weights), performing fewer than the maximum repetitions is advisable. A similar practice during periods of very heavy training reduces the total workout load slightly, and therefore decreases the risk of overtraining.

The phases of strength training

To achieve the best effects from strength training, regular training for a prolonged period (months to years) is usually required. One reason is that the tissues of the body (nervous tissue, muscle tissue, tendons and bones) are affected by the training at different rates. Therefore, cautious progression avoids overload injuries. In addition, free weight training and more goal-oriented strength training both demand a high level of technical expertise, which typically requires many months of basic strength training to develop while simultaneously avoiding overload injuries. An overview of basic strength training and the phases in a longer strength training program is provided below.

1. Basic strength training

The purpose of basic strength training is to gradually accustom the body to loading, without overtraining muscles, joints and tendons. This principle applies to those new to strength training, but also to those for whom strength training has not formed a regular part of their exercise regimen for some time. This phase is important preparatory training, especially for beginners, who need to become familiar with the various exercises and the elementary lifting techniques. For an athlete who has previously performed strength training, it prepares them to embark on a more advanced form of training. As mentioned earlier, individuals differ significantly in their rate of response to strength training. Therefore, the precise time it will take someone to reach a basic level of strength cannot be predicted. However, a rough estimate for someone who has not previously performed strength training is about

4–6 months. This period is somewhat reduced for those who have previously trained for a reasonable time.

As described previously, a marked improvement in muscle strength occurs within a few weeks of beginning training, which is primarily attributed to changes in neuromuscular control. In untrained people, very significant improvements occur because the ability of the central nervous system to activate muscles differs markedly between fit and inactive people. Heavy strength training improves neuromuscular control (the neural drive), especially in the development of explosive muscle strength (exercises with high RFD) and during maximum eccentric muscle contraction (contractions in which the muscle lengthens). Thus, previously untrained people can achieve increased muscle strength through improved neuromuscular activity alone. Increased muscle strength without increased muscle mass is often described as being due to qualitative changes in the muscles.

During the first few weeks of a training program, the weight load (intensity) should be relatively low (12–15 RM) and the person should train only 2-3 times a week to allow the body to recover between workouts (restitution). After about 6 weeks of training, a load that corresponds to 10–12 RM is used for around 8 weeks before increasing the load to about 8 RM. It is important to increase the load gradually to obtain the most benefit from the workouts and to avoid overload and injuries. Remember, however, that individuals differ in how rapidly they can progress. Increasing the training frequency to three times a week now gives the most benefit.

2. Building strength and technique

In this ‘transitional phase’, the focus is learning about the techniques of free weight lifting by slowly and gradually introducing them into the exercise program. From a wider perspective, the goal is to complete this period without injuries, because during this phase a marked imbalance occurs between the increasing muscle strength and the strength of the tendons and bones, which react more slowly to the increasing loads. This phase carefully prepares the body’s musculoskeletal system for the free weight training and the heavy training essential in the more sport-specific phase.

Training with machines is very beneficial and desirable because a maximum load can be applied in a safe and controlled fashion. For this reason, this form of training should constitute the majority of the training regimen. Exercise with free weights can be incorporated to improve muscle coordination and postural balance and to make the training more functional. Execution of the free weight exercises under strict supervision is recommended, as is a strong focus on correct technique. Learning the correct lifting techniques right from the beginning is essential to minimise the risk of overload.

The training intensity in this phase is typically about 6–8 RM when using machines, but a somewhat lower intensity is recommended for free weight training until the correct techniques become second nature. During this period, the training is further optimised by executing the lifting, or concentric, phase explosively (rapidly) and lowering the weight (the eccentric phase) at a steady, moderate speed.

3. Sport-specific strength training

A solid foundation of basic training and training in correct technique should have been established by the time this phase is reached. The athlete is now ready to proceed to more sport-specific strength training. The primary goal now is to execute high-intensity programs to further develop or maintain strength and to adapt the strength training to the demands of the specific sport. This is achieved by concentrating the strength training on the specific muscle groups and strength qualities required for the athlete's particular sport.

After a solid program of basic training, the muscle tissue now has considerable capacity to generate strength. Tendons and bone tissue have also similarly gained in strength. Additionally, the nervous system has adapted to more effectively activate the muscles, and coordination has been sharpened by the incorporated free weight training. Even after 12–18 months of training, large muscular and neural improvements are still possible—if the exercises are continually alternated and the training intensity is increased (1–6 RM). At this level, strength development is no longer linear: a small amount of improvement now requires proportionally a much greater amount and/or intensity of exercise. In other words, the development in strength exhibits a certain inertia the more well trained the athlete and the longer she or he has been strength training.

One reason why the positive effects of training continue in this phase is the use of exercise with free weights, possibly supplemented by simple exercises on machines. In addition, to challenge the nervous system, focusing on exercises that strengthen whole muscle synergies is advantageous, instead of using exercises that only strengthen a single muscle group. Depending on the athlete's primary sport and the desired results, the training should now be goal-oriented towards one—although, in some cases, both—of the two main types of strength adaptations, neural or muscular adaptations.

Unless muscle hypertrophy has been consciously avoided, a moderate to significant increase in muscle mass has probably already occurred. However, muscle mass can be further increased, depending on the form of exercise. If the desired muscle growth has been achieved and the primary focus now is to increase explosive muscle strength, the nervous system should especially be trained. In practice, this requires exercises of (very) high intensity (1–6 RM), limiting the number of repetitions, and not working until exhaustion. Primarily neural adaptations result, with only moderate or no muscle growth.

4. Maintaining strength training

In competition seasons or periods of increased sport-specific exercise, an athlete may be unable to spend much time strength training. However, basic fitness can be maintained by a single session of high-intensity strength training per week. Although maximum muscle strength cannot be preserved indefinitely, generally muscle strength can be maintained for up to 6 weeks, which is a necessity for sports with high-intensity competition periods. if strength training must be suspended for a period, training should recommence at a correspondingly lower level.

Periodisation

During prolonged periods of strength training (more than 6 months), exercise variation—also called periodisation—is especially important for continued muscular and neural development. After several years of training, most people experience a stagnation in development; at this time, periodisation becomes even more important for athletes who need to 'peak' at the right stage of the competitive season. This 'form topping' is achieved by dividing the sports season into periods and orienting the training within these periods towards the goal of optimal performance by the athlete at the desired time in the competitive season. The requirements of the various sports disciplines differ significantly: some sports aim for a single form peak per year (e.g. World Championships or olympics), while athletes in other sports (e.g. football) are expected to peak every weekend throughout a long season. The effectiveness of various periodisation models has been studied intensively; for further information, interested readers should consult the substantial body of literature available on this topic.

Approaches to strength training

As discussed earlier, the overall principle when strength training is to safely expose the muscles to external forces (e.g. weights or other external resistance) in a manner that produces changes in the neuromuscular system. For the desired effects, training with an external resistance load of about 1–15 RM is usually required. At external loads below about 15 RM, the physiological stimulus is not great enough for the muscle to 'register' the resistance as overload. Consequently, muscle strength does not increase, nor do the contractions develop greater explosive power.

Those who have not previously undertaken strength training may be surprised at the weights that need to be lifted, and it soon becomes clear why most strength training utilises strength training equipment (machines) and/or free weights to achieve results. Below we briefly discuss some pros and cons of the different forms of training.

The warm-up

As with all other types of exercise, it is important to perform a thorough warm-up to achieve the maximum benefit from the workout and to avoid injuries. Therefore, before performing specific strength exercises, warming up the general muscle groups is recommended to increase blood flow and the temperature of the musculature and the associated connective tissue (e.g. tendons and ligaments).

Using the bodyweight

in these 'free' exercises, the bodyweight is exclusively used to provide the load. This form of training primarily develops the muscle corset. The often simple exercises require little equipment and can be used as a part of the basic warm-up. Recommending a specific training intensity in RMs for free bodyweight exercises is impossible because the workload can seldom be regulated as with weight-training equipment. Nevertheless, these exercises are very import for the stability of the trunk muscles.

As part of this training of the muscle corset, training the pelvic floor is very important. With many strength workouts, the pressure in the pelvis rises markedly, thereby increasing the downward pressure on the pelvic floor. If the pelvic musculature is weak, the increased pressure will be transmitted to the bladder, which can lead to incontinence. Therefore, the pelvic musculature, like all other muscle groups, must be strengthened in preparation for the increasing demands of exercise.

Other free exercises such as the 'nordic hamstring' develop the eccentric strength of the posterior thigh muscles and are very effective in preventing injuries of the posterior thigh. The nordic hamstring exercise may also protect against injuries of the anterior cruciate ligament in the knee, as high hamstring strength helps stabilise the knee joint during dynamic movements.

Exercising with strength training machines

Training with machines is the most efficient method of training, unless a person has practised strength training for a long period. Therefore, this form of training should constitute the majority of the training regimen during the initial phases (basic and preparatory strength training). One of the advantages of this form of training is the high degree of safety when executing the exercises. Another is the ability to specifically train particular muscles and muscle groups. Training with machines also demands less coordination and balance, so when using high weight loads, this type of training is safer than using free weights of the same load. In addition, most machines can be calibrated for each individual. Therefore, the movements are controlled and the joints are not overburdened in extreme positions.

A disadvantage of this form of exercise is that the machines are expensive. Also, the movements that can be performed do not mirror natural movements as closely as those performed with free weights do. Thus, the nervous system is not challenged in the same way as when using free weights.

Training with free weights

The term 'free weights' encompasses dumbbells, barbells and weight plates. As noted above, one advantage of this form of exercise is that movements that are more natural can be performed. Also, related groups of muscles (muscle synergies) can be trained at the same time, for example, using the squat exercise. Moreover, some movements are difficult to perform in a machine, which is the primary reason why specific exercises with free weights are recommended for beginners. However, the weight load must be kept relatively low in the early stages, as the risk of injury is far greater when training with free weights compared to training with machines. The increased risk occurs because correct technique and good balance and coordination skills are required when using free weights. The risks are obviously more pronounced at higher weight loads, especially if the athlete loses balance and makes an unplanned movement. To minimise risk with high weight loads, having a partner assist is advisable. As noted earlier, heavy free weight training is only recommended for those highly experienced in strength training. However, including some free weight exercises with low weight loads early in a training regimen can be advantageous, especially for developing a correct technique.

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