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COACH IN RUNNING FITNESS

THE COMPONENTS OF FITNESS

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THE COMPONENTS OF FITNESS

In athletics, records are made to be broken. Men and women, boys and girls, around the world continually challenge their personal performances and improve upon record performances in all events. These improvements in performance are generally a result of higher levels of fitness combined with effective technique. The higher levels of fitness come from an improved understanding by coaches and athletes of training and its effects.

Information, knowledge and experience in fitness development is used by the coach, along with the knowledge he has of the athlete, to produce effective training programmes. But before you begin to look at building training programmes it is important to understand what is meant by 'fitness' and how it can be developed.

WHAT IS FITNESS?

Fitness is how well a person is adapted to and capable of living a certain lifestyle. The fitness of an athlete is generally greater than that of the non-athlete. The athlete needs to be fit for the demands of his chosen athletic event in addition to being fit for the demands of day to day living. But what is fitness made up from? The principle of specificity states that there is a specific response to the specific nature of a training load. This specific response will tend to emphasise one or more of the components that make up fitness. These components of fitness are basic and respond well to training.

THE COMPONENTS OF FITNESS

There are five basic components of fitness and these are endurance, speed, strength, flexibility and coordination.

- Endurance
- Speed } Power
- Strength } Power
- Flexibility
- Coordination

Each exercise in training will tend to develop a particular component of fitness. For example, when distance or duration is extended or maximal the exercise becomes endurance based. Quickness and frequency of movement would give a speed exercise. If the load of an exercise is high or maximal it is a strength exercise. The ability to move through a wide range of joint motion would be a flexibility exercise and activities that have relatively complex movements are called coordination exercises. This is a simplified view and in practice exercises usually develop two or more of the components of fitness.

Different events have different demands on fitness. The fitness of a distance runner is obviously very different to the fitness of a shot putter.

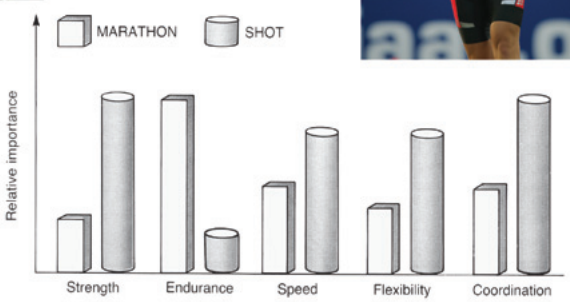


Figure 1

To provide a fitness foundation for all athletes and later to develop the specific fitness required for an event it is necessary for the coach to understand the characteristics of the five components of fitness and how to develop them.

DEVELOPING ENDURANCE

Endurance refers to the ability to perform work of a given intensity over a time period and is sometimes called 'stamina'. In athletics the word 'endurance' is used for both a component of fitness and for an event group. In this section we shall consider 'endurance' as a component of fitness and while walking and running are ways of developing endurance, they are used to illustrate the development of endurance, it could easily be strength and conditioning activities or speed activities.

The main factor which limits and at the same time affects performance is fatigue. An athlete is considered to have good endurance when he does not easily fatigue or can continue to perform in a state of fatigue. Endurance, of all the components of fitness, is a foundation, as without endurance it is difficult to repeat other types of training enough to develop the other components of fitness. There are two basic types of endurance:

- Aerobic endurance
- Anaerobic endurance

AEROBIC ENDURANCE

Aerobic means 'with oxygen' and aerobic endurance means muscular work and movement done emphasising the use of oxygen to release energy from the muscle fuels. We have seen how the absorption and transport of the oxygen to the muscles is carried out by the cardio-respiratory system. Aerobic training leads to both a strong cardio-respiratory system and an increased ability to use oxygen in the muscles. Aerobic endurance can be developed, for example, by continuous or repetition running. The longer the duration of an event the more important is aerobic endurance.

ANAEROBIC ENDURANCE

Anaerobic means 'without oxygen' and anaerobic endurance refers to the energy systems which are capable of operating without oxygen present. They allow muscles to operate using energy they already have in store. Anaerobic training of the right type that strongly emphasises the lactate system allows the athlete to clear and tolerate the build up of the 'acid' part of lactic acid. But this type of intense training should only be done with experienced athletes in the event group development stages, or later. Always remember that lactic acid does not exist in the body. As soon as it is formed it separates into a 'lactate' bit and an 'acid' bit. We have seen that the acid is the 'bad guy' but the athlete can use the lactate as a fuel source.

There are two important types of anaerobic endurance. The first is speed endurance which involves principally the aerobic and lactate systems but emphasises the lactate system. Developing speed endurance helps an athlete to run at speed despite the build up of acid. The second type of anaerobic endurance is the endurance needed to maintain maximal velocity speed in sprinting, hurdling, throwing and jumping, where the alactic system is emphasised. For an athlete in the Foundation stage of development they may only be able to accelerate to maximal and then only have the physical and mental endurance to 'hold' that maximal speed for a relatively short distance of 10-20 metres. In the Event Group Development stage, and now with greater experience, the athlete may have the anaerobic alactic endurance to be able to hold maximal speed for up to 30 metres.

DEVELOPMENT OF AEROBIC AND LACTATE ENDURANCE

The most important types of endurance training using walking and running are:
- Continuous Training
- Non-continuous or Repetition Training

Continuous training simply means walking, running or doing whatever training activity without rest. Continuous training may be used to develop general endurance, specific endurance and for recovery. It usually takes place away from the track and provides a variety of pace, location and running surface in the athlete's training. Runs may be short, medium or long but it should be remembered that 'long' and 'short' are relative to the stage of development of the athlete and their fitness levels. The same distance might be a 'short' run for one athlete and a 'long' run for another athlete. The other type of continuous training which may be used throughout the year is 'Fartlek' training, where the athlete 'plays' with a variety of running speeds or rhythms.

Repetition training is breaking a total distance or any training load into smaller units which are repeated, hence repetitions. In walking and running the pace, distance and rest/recovery intervals and activity are prescribed. This type of training is usually done on the track but may be done in a park on grass or anywhere. Repetition training can be divided into two main types by pace or running rhythm: extensive and intensive. When the training emphasis is on general endurance, extensive repetition training is used; when the emphasis is on event-specific endurance, intensive repetition training is used.

Training loads are usually defined by the following parameters:
- Volume can be described by the running distance (m, km, miles) or the running time (sec, min, hours) or by the number of repetitions or number of sets of repetitions.
- Intensity, which would be the pace, rhythm or running speed (min/km, min/mile, seconds per 400m lap, or the perceived rhythm, etc.)
- Rest/Recovery is the time, or interval, between different repetitions or sets of repetitions (sec, min or distance) and the activity (from occasional passive, standing recoveries to, more usually, active recoveries using walking, to easy running, to more active running).

DEVELOPING GENERAL ENDURANCE

General endurance is developed mainly through continuous, extensive repetition and fartlek training. The pace used for both these methods should be based on the athlete's running rhythms. These methods should be applied throughout the training year, using the following guidelines and remembering that continuous training runs should also be used throughout the year for recovery and regeneration. When using continuous running always remember that runs may be 'short', 'medium' or 'long' and this is relative to the stage of development of the athlete and their fitness levels. The same distance might be a 'short' run for one athlete and a 'long' run for another athlete.

For athletes in the Foundation stage of development the use of Fartlek can be particularly useful since it normally takes place away from the track in a safe parkland or woodland environment and the athletes can feel in control of the running rhythms. The fartlek environment can be structured to optimise fun for these Foundation athletes, as it actually can be for any stage of athlete development, and the pace should be rhythmic 'speed-play'. For athletes in the Foundation stage the duration of the fartlek could be 5' - 15', while in the Event Group Development stage it would usually be something between 10' - 20' duration. The 'easier' recovery sections should always be active running and fartlek should not be a 'sprint' then 'jog'.

Athletes with a high training age who are in the Specialisation and Performance stages may do fartlek sessions for any duration from 10' to generally no more than 45'. For all fartlek running the 'easier' recovery sections should always be active running and fartlek is not intended to be a repeated 'sprint' then 'slow jog'.

For adult runners, athletes in the Event Group Development and later stages there can be a greater variety of training sessions including:

- Slow Continuous Runs (Goal: regeneration)
  Pace: Easy rhythm; Volume: up to 30 minutes; Rest: not applicable.
- Long Slow Distance Runs (Goal: general endurance)
  Pace: Marathon rhythm and slower; Volume: 60-150 minutes; Rest: not applicable.
- Medium Continuous Runs (Goal: general endurance)
  Pace: ½ Marathon to Marathon rhythm; Volume: 30-60 minutes; Rest: not applicable.
- Fast Continuous Runs (Goal: general endurance)
  Pace: 10 Km to ½ Marathon rhythm; Volume: up to 10-45 minutes; Rest: not applicable.
- Extensive Repetition Training (Goal: emphasise aerobic endurance)
  Pace: 3000m to 10,000m rhythm; Volume: increases with the competition distance; Rest: depends on the individual runs in the sessions (see sample sessions).
- Fartlek (Goal: aerobic and lactate endurance)
  Pace: rhythmic 'speed-play'; Volume: 10-45 minutes, increases with the competition distance; Rest: not applicable but the 'easier' sections should still be active running.

Here are some sample extensive repetition sessions suitable for athletes in the Foundation stage of athlete development:

a) 2 x 4 - 5 x 200 m (3000m pace) [easy running for 60", between sets: 5 min]
b) 4 - 6 x 500 m (5000m pace) [easy running for 90"]
c) 1 min, 2 min, 3 min, 2 min, 1 min (mid X-country race pace) [easy running for 60"]

Here are some sample extensive repetition sessions for athletes in the Event Group Development or later stages:

a) 2 x 10 x 200 m (3000m pace) [between reps = to running time, between sets: 5 min]
b) 15 x 400 m (5000m pace) [between reps = to running time]
c) 1 min, 2 min, 3 min, 2 min, 1 min (10,000m pace) [between runs = to running time]

It is important to remember that when using extensive repetition training the coach must monitor the pace carefully to ensure it stays within the prescribed rhythm and does not compromise the athlete's ability to complete the session. Running too fast during extensive repetition training is a common mistake.

REPETITION TRAINING AND INTERVAL TRAINING

Repetition training may also be divided into two main types according to the recovery activity that takes place during the 'intervals', the time between the faster repetition sections.

- Repetition Training
- 'New Interval Training'

In standard Repetition Training the rest period between repetitions and sets may be passive, walking or easy running. But in the 'New Interval Training', which has become popular because of its effectiveness in developing both the aerobic and lactate energy systems, the recovery in the intervals is a very active 'roll-on', running recovery. The New Interval Training is a type of repetition training where the training effect occurs in the interval between the faster sections. Only repetition training that has the training effect taking place in the interval should be called 'interval training'. To compare a classic repetition session for an experienced athlete of 15 x 400 (3000m pace) [90"] with new interval training:

New interval training sessions:

15 x 400 (5000m pace) [100m roll-on] or
3 x 5 x 400 (3000m pace) [100m roll-on & 3 mins] or
3 x 5 x 400 (5000m, 3000m, 5000m, 1500m, 5000m) [100m roll-on & 800m roll-on].

For less experienced athletes in the Foundation stage the new interval training may be:

2 x 4 - 5 x 200 (3000m pace) [100m roll-on & 5' between sets]
or, to develop changes in rhythm:
3 x 3 x 200 (5000m, 3000m, 5000m) [100m roll-on & 3' between sets].

What does 'a very active roll-on, running recovery' really mean? Some coaches find it useful to ask athletes to imagine that they are riding a bicycle. When you are pedalling along it is like being in the faster repetition distance of the session. When you come to the recovery interval it should feel like you stop pedalling – but you do not touch the brakes at all – you just roll, naturally, on.

This very active 'roll-on', running recovery could be 25" to 35", or more, per 100m for an inexperienced athlete, depending on their natural abilities and fitness. For experienced juniors and seniors in the Specialisation and Performance stages of athlete development, a 100m roll-on may easily be 25" or less. The roll-on recovery distance can be 100m, 200m, 300m or any distance that is suitable to the stage of development of the athlete, to provide variety and create different effects on the lactate energy system.

In summary, it is true to say that the term 'interval training' should only be used for the specific repetition training where the training effect takes place in the interval between the faster sections. So we can say,
"Interval training is always repetition training but not all repetition training is interval training."

The effective coach knows this important distinction and uses the correct term to describe the training to be undertaken.

All repetition training can be varied by:

- **Repetitions** The total number of repetitions in a session – may be divided into sets
- **Duration** Length of time or distance of one repetition
- **Intensity** Rhythm, pace, speed or velocity of the repetitions
- **Recovery** Time of the intervals between repetitions and sets
- **Recovery activity** From a walk to easy running or more active as in new interval training

PACE FOR ENDURANCE TRAINING

Coaches use 'pace' in planning endurance training and it should mean,

"The running rhythm the athlete would use if they were racing that distance today - not their personal best"

Pace can be used as a guide for an athlete's running rhythms for their continuous or repetition training. For example, '800m pace' means the running rhythm for this repetition will be the same rhythm as the athlete would have used if they had been racing in a 800m race that day. But this should be their 800m mid-race rhythm and not their 800m finishing pace. Coaches planning training for running sessions should avoid using 'target times' for their athlete's repetition training. For example, a 36 seconds time for 200m might be an 'easy' effort for an athlete on a day when they are 'fresh'. The same time of 36 seconds may feel much harder and produce a different physiological response, or be unachievable for that same athlete, if the athlete is very fatigued.

To repeat, '3000m pace' means the running rhythm for the repetition will be the same mid-race rhythm as the athlete would have used if they had been racing a 3000m race that day, the day of the actual training, not their personal best for the distance. For example, an 82 seconds time for 400m might be an 'easy' effort for an athlete on a day when they are 'fresh'. The same time of 82 seconds may feel much harder and produce a different physiological response if the athlete is very fatigued from training, from other things in their life or if the weather is not good through wind, rain and/or temperature.

Using running rhythm and 'pace' means that the speed of the repetitions is adjusted each day to the athlete's fitness and energy levels. With training groups, using target times may fit one or two athletes in the group but not most of the athletes in the group. Using 'pace' means that every athlete trains at their individual rhythm and level of performance, developing the fitness that they need.

DEVELOPING EVENT SPECIFIC ENDURANCE

Event specific endurance is developed mainly through intensive repetition training and only becomes a focus once the athlete has entered the Specialisation or Performance stages of athlete development. The pace used for this method should usually be the athlete's running rhythm for that event but may, close to the competition season during the competition period, be based on the target time for the competition distance.

Intensive repetition training, called 'acidosis training', leads to high concentrations of acid in the body and should be used carefully, if at all, with younger athletes.

- Intensive Repetition Training (Goal: event specific endurance)
  Pace: Based on event specific pace; Volume: increases with the competition distance; Rest: depends on the individual efforts in the session

The following table shows the types of repetition training you can do to develop endurance with an emphasis on the lactate system compared to the training with an emphasis on the aerobic system.

LACTATE/Aerobic		AEROBIC/Lactate
Relatively low	Total Repetitions	Relatively high
10 secs-2+ min	Duration	2-60+ mins
80m-600m+	Distance	300m-1200m+ or Continuous
80%-100%	Intensity	50%-75%
30 secs-10 mins	Recovery	30 secs-3 mins
Walk/easy run	Recovery activity	Easy/active run

Comparison of repetition training to shift the emphasis of endurance development from the Lactate to the Aerobic system

As we have seen, 'endurance' is used in two ways in athletics. It is used for an event group, which includes middle and long distance running and race walking, and as a component of fitness. This can be confusing and lead to some coaches to think that endurance is only relevant to the events of the endurance event group. But the 100m runner or the sprint hurdler needs endurance to maintain their maximum speed to the end of the race. The throws and the jumps events require athletes to have enough endurance to maintain performance through all the rounds of those events. This type of endurance emphasises predominantly the alactic energy system. To develop this we have to use repeated maximal efforts of short duration with sufficient recovery:

	Alactic
Duration →	0-10 secs
Distance →	20m-80m
Intensity →	Maximal
Repetitions →	3-4
Recovery/Reps →	2-3 mins
Sets →	1-4
Recovery/Sets →	5-8 mins

Developing anaerobic endurance emphasising the alactic energy system

DEVELOPING SPEED

Speed is the capacity to travel or move very quickly. Like all the components of fitness, speed can be broken down into different types. It may mean the whole body moving at maximal running speed, as in the sprinter. It may involve optimal speed, such as the controlled speed in the approach run of the jumping events. Or, it may include the speed of a limb, such as the throwing arm in the shot or discus, or the take off leg in the jumps.

Speed includes the following types:

- **Maximal speed**
  - As fast as you can
- **Optimal speed**
  - Controlled speed - the best average speed for whatever distance you are walking or running
- **Acceleration speed**
  - The rate of change in speed
- **Reaction time**
  - The time between a stimulus and the first movement of the athlete. Includes the reaction to the gun in the crouch start but also to how quickly an athlete responds to something in an event
- **Speed endurance**
  - The ability to continue to express either maximal or optimal speed as fatigue levels increase.

At birth and through infancy a child's nervous system is in place but is not fully developed. As the nervous system develops and matures in childhood it becomes capable not only of sending clearer messages down the nerves but also capable of sending these clearer, more precise, messages down the nerves at a quicker, faster rate. The time when the nervous system has matured sufficiently so that the child can make and learn accurate muscular movement coincides with the time when the child can now make quicker movements. The time immediately following this nervous maturation can be considered as ideal for the development of skill and speed.





In fact, we have seen that skill and speed are not the only components of fitness that have windows of opportunity. The diagrams for the developmental windows of opportunity for boys and girls show additional opportunities, for the development of strength and a second time for speed.

The first 'speed window' is related to the development of the nervous system and its ability to now carry messages much more quickly. This speed window does not mean that the athlete should now suddenly start doing 100m sprint repetitions. Instead during the Fundamentals stage there should be a development of reaction movements and quickly initiated movements. This can be done through a variety of speed-based multi-directional movements and games based on activities lasting less than 4-5 seconds with adequate recovery in between.

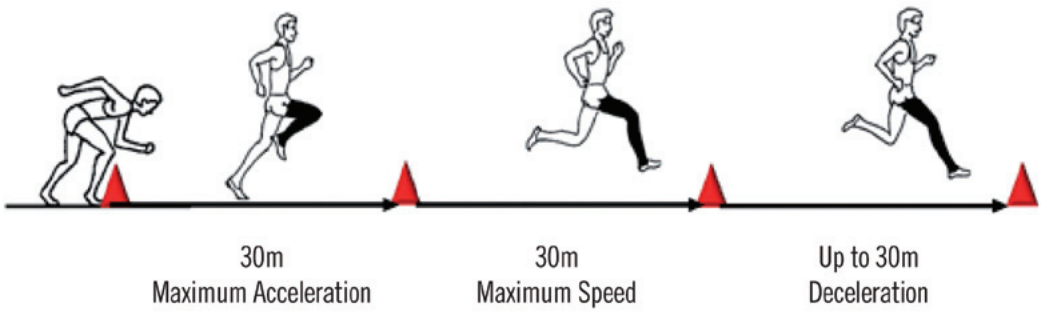
The second speed window occurs in adolescence due to the continuing development of the nervous system now having the addition of the developing energy systems. During this speed window all types of speed related work may now be carried out to the benefit of the developing athlete, if they are in the Event Group Development stage.

DEVELOPMENT OF SPEED

Speed training involves development of a skill so that the technique is performed at a faster rate. To develop speed the skill must be practised on a regular basis at a maximum or close to maximum rate of movement. Maximal running speed, for example, is developed by runs over short distances at maximum effort. Perhaps the foundation exercise for developing maximal speed is the 'Flying 30s' which are maximal sprints over 10 m, 20 m, 30 m or even 40 metres. The most common distance for senior athletes is 30 metres which is why the exercise is known as 'Flying 30s'.

The coach marks out an acceleration zone of 30m, and a 'maximal speed zone' of 30m with a run-out for controlled deceleration of up to 30m, as shown in the diagram. The skill of moving at speed should, like all skills, be practised before the athlete becomes fatigued. For this reason recovery times between repetitions and sets should be long enough to recover from any fatigue. In the case of this exercise which emphasises the alactic energy system there should be recoveries of 2 - 3 mins between repetitions and at least 5 - 8mins between sets.

Because this exercise requires intense effort and concentration to achieve maximal speed, there should not be more than 3 repetitions in a set. The coach can make the Flying 30s the whole session such as 3 x 3 x Flying 30s (max) [2' and 5'-8'] or part of the session, provided it is at the beginning when the athlete is not fatigued, such as 2 x 2 Flying 30s (max) [2' and 5'] before moving on to another activity.



Flying 30s for the development of maximal velocity sprinting

The athlete accelerates maximally from a standing start position so that they attempt to achieve maximal velocity before the 'maximal speed zone'. Through the maximal speed zone the athlete tries to maintain frequency, how quickly their legs are moving. The athlete should not show any acceleration in the maximal speed zone as this should have already occurred. If the coach observes an athlete slowing on the maximal speed runs during a session he should stop the practice and move on to something more appropriate since the athlete is no longer practising maximal speed.

If the athlete has a low training age eg a new to running or returning to running adult is in the Foundation stage, or is young they may be capable of 'Flying 10s' where the 'maximal speed zone' is just 10 metres long. But the acceleration zone should still be 30m and the deceleration zone should still be up to 30m. They can then develop to 'Flying 20s' and for senior athletes with a high training age and a stable, uninterrupted training background, to 'Flying 30s' and even to 'Flying 40s'.

REACTION TIME

When considering speed it is important to include reaction time. Reaction time is the time between a stimulus and the first movement by the athlete, such as the firing of the starter's pistol or responding an overtaking or pace increase move during an event. There are many factors both physiological and psychological which influence reaction time and the initiation of movement. It also includes the athlete's response to what happens during a competition. How long does it take the athlete to react? Simple reaction time games can be great fun for young athletes and in the Fundamentals and Foundation stages of athlete development these games ensure that the first window of opportunity for speed is optimised.
Reaction time for athletes of all chronological ages and training ages can be improved with practice, provided the practice situation is realistic.

	Alactic
Duration →	0-10 secs
Distance →	20m-80m
Intensity →	Maximal
Repetitions →	3-4
Recovery/Reps →	2-3 mins
Sets →	1-4
Recovery/Sets →	5-8 mins

Summary of the development of speed emphasising the alactic energy system

With a clear understanding of the different types of speed the coach can devise exercises to develop and improve the athlete's speed capacities, at the right time in an individual athlete's developmental pathway and in the correct way.

DEVELOPING STRENGTH

Muscular strength is the ability of the body to exert force. Strength is important to every event for both men and women, provided this is functional strength. Muscle fibres within the muscles respond when subjected to weight or resistance training. This response makes the muscle more efficient and able to respond better to the central nervous system.

Strength is a very important component of fitness for all athletes but the important question is frequently asked, "Is training for strength appropriate for children and young athletes?" With a sound knowledge of growth and development and the stages of athlete development, the coach now knows that young athletes can begin learning the 'techniques of free weight lifting' from about the ages of 8-11 years when they are in the 'skill' window of opportunity. Then, once they are mature enough and have entered the 'strength' windows of opportunity, they can start 'free weight training' for strength gains.

STRENGTH

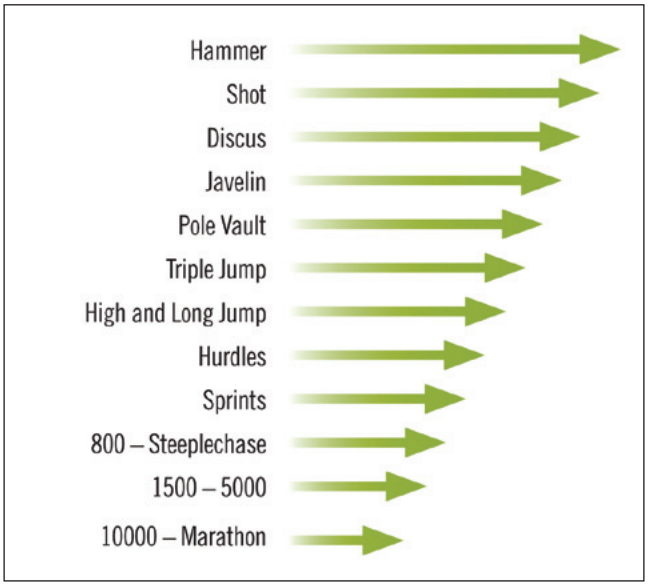
Muscular strength is the ability of the body to exert force and may be broken down into four types:

- Maximum Strength
- Power
- Strength Endurance
- Reactive Strength

MAXIMUM STRENGTH

This is the greatest force that a contracting muscle can produce. Maximum strength does not determine how fast a movement is made or how long the movement can be continued. It is relatively more important in events where a large resistance needs to be overcome or controlled.

The relevance of maximum strength for all athletics events is often ignored. Maximum strength is a necessary basic quality as a foundation for power development but has little value in itself. Athletes should be strong but not be 'weightlifters' and their maximum strength must be evaluated in its contribution to their abilities as a powerful athlete.



Representation of maximum strength contribution to various athletics events

POWER

Power is of obvious importance in the 'power' events of sprinting, hurdling, jumping and throwing but is still of importance in those events which emphasise endurance such as walking and distance running.

Power is the interaction of strength and speed, the relationship between speed of contraction and speed of movement. It relates how quickly an athlete can produce force and not merely how much force they can produce. Successful athletes are powerful athletes and this quality of strength should be developed, once a foundation of maximum strength has been developed. Power is of obvious importance in the 'power' events of sprinting, hurdling, jumping and throwing but is still of importance in those events which emphasise endurance such as walking and distance running.

STRENGTH ENDURANCE

This is the ability of the muscles to continue to exert force in the face of increasing fatigue. Strength endurance is simply the combination of strength and duration of movement. Performing an exercise, such as sit-ups, to exhaustion would be a test of strength endurance. This strength characteristic determines an athlete's performance where a movement is repeated over a fairly long period of time. Runs between 60 seconds and 8 minutes, for example, require a lot of strength endurance. The ability to sprint, hurdle, throw or jump repeatedly in training or competition and maintain performance levels also requires strength endurance.

REACTIVE STRENGTH

Reactive strength is the potential of the athlete to use the elastic properties of their muscles and tendons. When a muscle works eccentrically, that is when the muscle is creating force but the dynamic contraction results in a lengthening of the muscle, it 'stores' energy. We have seen this in the CiRF Body in Sport resource where you can see a picture of an athlete jumping down from a box to the floor and then springing up again (pg 9). It is often over-looked in the running and walking events but provides a vital element to performance in these, as well as in the traditional 'power' events.

This storage of energy by the muscles and tendons is similar to when you stretch a rubber or an elastic band. As you stretch the band it becomes longer and stores energy. If you release the band it very quickly, almost explosively, releases the stored energy and returns to its normal length. In athletics this process is called the 'stretch-shortening cycle', also known simply as the SSC. The stretch-shortening cycle describes the capacity of the muscles and tendons to produce high concentric forces within a very short time after an eccentric stretch. These high concentric forces are called reactive strength.

Unlike maximum strength and power there are two specific mechanisms in reactive strength:

- **Storage of energy** - while stretching energy will be stored (eccentric phase)
- **Reflex actions** - this permits energy to be regained at shortening (concentric phase).

Reactive strength is an independent dimension of strength and will not automatically be improved by higher maximum strength or power capacity. It is often over-looked in the running and walking events but provides a vital element to performance in these, as well as in the traditional 'power' events.

DEVELOPMENT OF STRENGTH

Weight training and resistance training will both develop strength. If there is an increase in muscle mass as a result of training this is called hypertrophy. Muscle hypertrophy is associated more as a result of training for maximal and reactive strength rather than strength endurance. When strength training stops the law of reversibility indicates that some strength will be lost and the muscle mass may reduce. Reduction in the muscle mass is known as atrophy. Muscle atrophy is a direct result of low, or no, activity and may be a factor in injury rehabilitation.

Maximum strength is best developed by exercises which involve a low number of repetitions and a large resistance or loading. Power is developed through fast repetitions using an appropriate loading and strength endurance is developed using a high number of repetitions with a low resistance. Reactive strength is developed by using exercises which utilise the SSC such as bounding. These methods can be combined by the coach into an overall strength programme and these combinations will vary for different events.

For young athletes the strength 'window of opportunity' is related to the hormonal changes that occur at puberty. When the athlete reaches this level of maturity they can safely shift from 'weight training for technique development' to 'weight training for strength gains'. Testosterone is the hormone associated with the development of secondary male sexual characteristics
but it is important to note that this hormone is also present in females. In females it is present in much less significant amounts than males and once puberty occurs for girls the hormone responsible for female characteristics, oestrogen, becomes dominant. For girls there are effectively two strength windows. The first occurs just prior to puberty when any strength gains and nervous adaptations achieved at this time will remain after puberty. The second window for girls occurs after puberty when further strength training for functional strength development can commence.

For boys, the window of opportunity for strength occurs in the twelve to eighteen months after puberty, as testosterone levels rise and peak. Boys could do strength training before puberty but the effects would not be as effective as waiting for the testosterone levels to rise.

FREE WEIGHTS

The term 'free weights' is given to weights that, when they are moved, the path of the weights is free to move anywhere. Free weights include barbells and dumb-bells. Barbells are long bars that are held by the athlete with two hands. Dumb-bells are short bars that permit weight to be lifted with either or both hands. The advantages of sometimes using dumb-bells include identifying muscular imbalances. With free weights, whether using a barbell or dumb-bells, where and how the weights move is controlled 100% by the athlete. With 'machine weights', while the athlete may be able to lift very heavy weights, the path of movement of the weights is controlled by the machine.

The advantages of using free weights, rather than machine weights, include:

- Offering a greater variety of movement
- Muscular imbalances are highlighted
- Permit whole body exercises which help develop stability of the joint areas
- Producing greater power output than machine weights
- Contributing to the development of core stabilisation strength.

It is recommended that all athletes use free weights where ever possible, provided that they are training under appropriately qualified individuals. Machine weights may have some role to play in the initial rehabilitation after injury but for the healthy athlete machines do not develop functional strength. Machine weights are also expensive and require more maintenance. With free weights it is possible to improvise inexpensive, safe and appropriate equipment and environments.

In strength training the following terms are used to describe an exercise:

- **Resistance**
  - the load a muscle or group of muscles is required to move
- **Repetitions**
  - the number of times the exercise is performed without stopping, referred to by coaches and athletes as 'Reps'
- **Sets**
  - a specified number of repetitions comprises one set.

Three sets of ten repetitions, for example for a back squat exercise would be written:
Back Squat 3 x 10 x (resistance) [recovery between sets]

For structuring weight training sessions to develop strength for athletes in the Specialisation and Performance stages the coach should think of using the '3-5 Rule':

The '3-5 Rule' for Strength Training
- 3-5 Sessions per week
- 3-5 Exercises per session
- 3-5 Sets per exercise

and for maximal strength or power:
- 3-5 Repetitions or Reps per Set
- 3-5 Minutes recovery between sets

This 'rule' is intended as a useful guide to structure successful weight training sessions but in practice it may not be possible to have the time to schedule 3-5 weight training sessions per week. Or, it may not be appropriate to the stage of development of the athlete to have 3-5 weight training sessions per week. If this is the case, a minimum of two strength sessions per week are necessary to develop strength.

YOUNG ATHLETES AND WEIGHT TRAINING

As was stated earlier in this section on 'strength', young athletes should learn the techniques of weight lifting at a young age and then use weights for strength development when they are mature enough, provided that they have a sufficient training age. For strength endurance they can use resistance exercises with bodyweight, circuit training and medicine ball exercises.

STRENGTH ENDURANCE TRAINING AND CONDITIONING

The development of muscular conditioning depends on a number of factors. These factors include the stage of development and experience of the athlete, the type of strength that is to be developed and the facilities available. Exercises that use body weight alone as a resistance are a good way to start strength endurance training, especially for younger and inexperienced athletes.

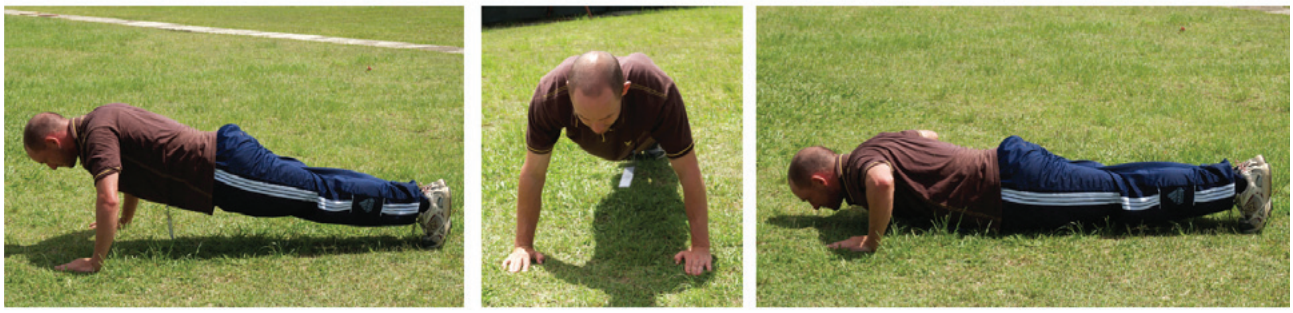
There are also resistance exercises which require a minimum of equipment. An example of these is an exercise using medicine balls. A medicine ball, or an improvised, similarly weighted object, can be used not only to develop general strength, but also the specific strength and coordination required for walking, running, jumping and throwing.

EXERCISES USING BODY WEIGHT

Exercises that use an individual's body weight are very effective. They require no equipment or facilities and you can do them anywhere. Body weight exercises offer the opportunity for variety and progression. This can be seen with some of the variations available on a simple exercise such as press-ups, also known as push-ups.

PRESS UPS

The basic press-up is carried out from a front support position with a straight back and the head in natural alignment with the spine. The arms should be shoulder width apart. If strength levels are low, the athlete may rest the lower body on the knees rather than the feet.



Variations on the Press-up:

Finger tip Press-up	Front support on finger tips
Press-up touching chest	Touch your chest in between press-ups
Press-up clapping hands	Clap your hands in between press-ups
Press-up with feet raised	Front support with your feet on a bench or box
Press-up raising one leg	Raise alternate straight legs each time you lower the body
One arm Press-up	Front support with one hand behind your back
Press-up from handstand	From a handstand against a wall, touch your forehead to the ground

Here are some more examples of resistance exercises using body weight alone:

TRICEPS DIP

Back support using a chair or box, starting in the 'up' position.

SIT UPS

With bent knees and hands on the chest, shoulders or sides of the head - not clasped behind the head. Draw the navel towards the spine before moving upwards.

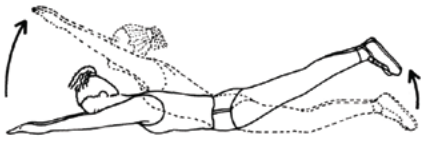


LEG RAISE

Lying down but with the upper body raised up onto the elbows. Ankles are dorsiflexed and legs are raised one foot's length above the ground.


BACK EXTENSION

Lying face down alternately raise arms and then legs.



CHINNIES

Sit-ups bringing alternate elbows to opposite knee.



SQUATS

Standing with feet shoulder width apart, squat as low as the athlete is able.



SQUAT JUMPS

From a standing position repeatedly make a quarter squat and then jump as high as possible. On landing, sink the hips into another quarter squat position to absorb the landing and immediately jump again as high as possible.



CIRCUIT TRAINING

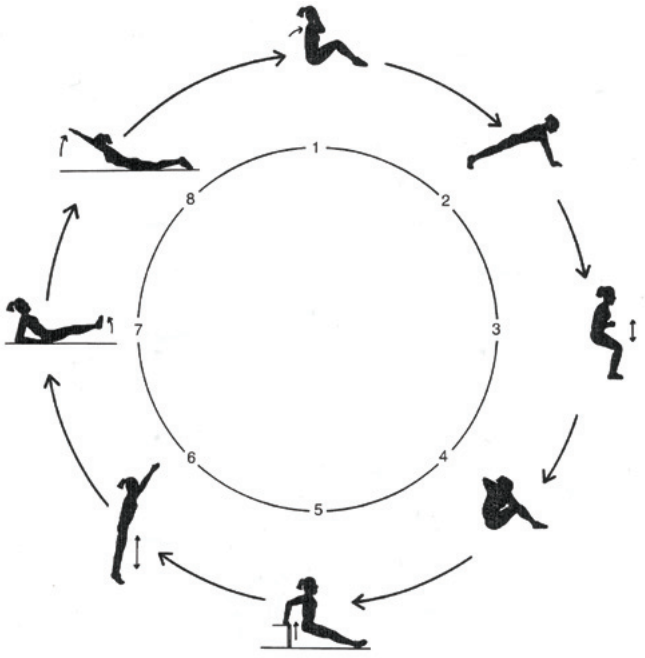
Circuit training is the term given to resistance exercises grouped together to achieve general or specific conditioning. Circuit training improves strength endurance, it does not increase strength. Exercises are performed in a circular arrangement which allows athletes to progress from one exercise "station" to the next until all stations have been visited. The completion of all exercises is one circuit. This type of training is ideal for small or large groups of athletes working together.

The coach should think of the body in four basic areas when planning a circuit training session.

Exercises for each area should be worked in sequence, so that one leg exercise, for example, is not followed by another leg exercise.

The volume and intensity of exercises can be varied in many ways to make circuit training progressively demanding. Time is a good guide for setting work loads for the beginner. It allows each individual to perform the number of repetitions they are capable of and can easily be monitored by the coach.

The following is an example of a general conditioning circuit, using body weight as a resistance.



A general conditioning circuit

Number of circuits ..... 1 - 5
Time at each station ..... 30" - 1' 30"
Recovery between exercises .... 15" - 45"
Recovery between circuits ..... 2'- 5'

EXERCISES WITH MEDICINE BALLS

The following are examples of exercises using a medicine ball:

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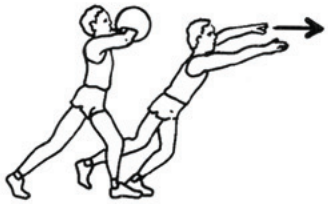

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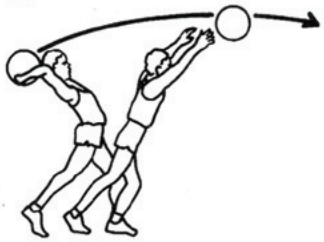

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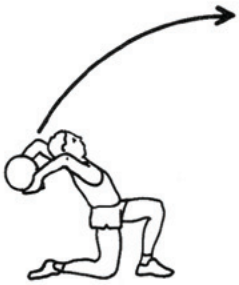

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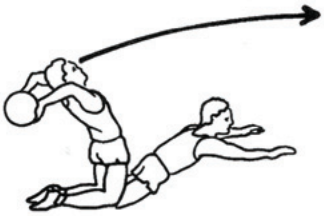

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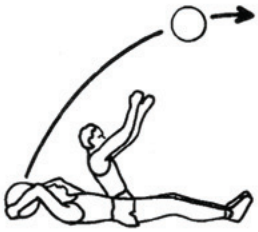

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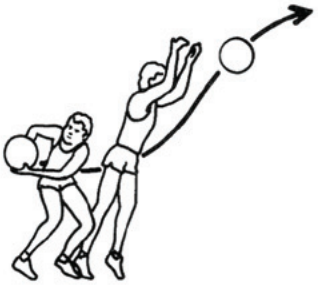

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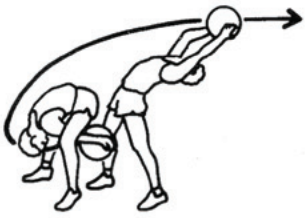
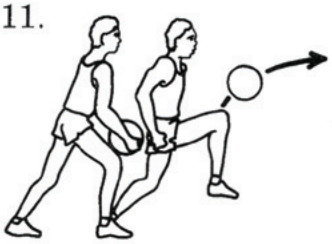


10.


11.


12.


DEVELOPING FLEXIBILITY

Flexibility is the ability to perform joint actions through a wide range of motion. The natural range of motion of each joint in the body depends on the arrangement of tendons, ligaments, connective tissue and muscles. The limit to a joint's range of motion is called the 'end position'. Injuries can occur when a limb or muscle is forced beyond its normal limits. Flexibility training may not reduce the risk of injury by gradually increasing a joint's range of motion but may help to express power through the optimal range of motion.

Restricted flexibility is one of the common causes of poor technique and performance. Poor flexibility can also hinder running speed and endurance since the muscles have to work harder to overcome the resistance to an efficient stride length. Flexibility tends to decrease as we get older, while females are usually more flexible at all ages. Young athletes should do regular individualised stretching programmes to develop flexibility where it is needed and maintain existing flexibility. This can prevent the loss of flexibility that comes with age.

A traditional broader definition of flexibility has been,

"the ability to perform a range of movement in a joint or a series of joints."

Coaches and athletes have over many years created many ways and means to enhance flexibility. Unfortunately, many of these methods have improved flexibility but may have been carried out at the wrong time to benefit the training session or competition or have given improvement at the cost of joint stability. Traditional passive stretching has been incorrectly used for several decades based on the ritual of a typical athletics warm up routine. For the past several years there has been an increasing use by informed and innovative coaches of a much more active, dynamic approach to flexibility exercises in the warm up. These more active, dynamic exercises are called 'mobilisation exercises' and are designed to prepare the body for the session which follows.

There are two main types of flexibility activities:

- **Flexibility exercises in the warm up**. Mobilisation exercises should be chosen for the warm up which access the existing range of motion (ROM) and prepare the body for the activity about to be undertaken

- **Flexibility exercises to increase ROM.** These exercises are aimed primarily at a long term programme to increase the range of motion, ROM, in a joint or series of joints. These exercises may be part of a cool down to a session or form a separate flexibility session itself.

FLEXIBILITY IN THE WARM UP

There is no evidence that traditional passive type stretching lowers the chance of becoming injured, which is one of the main reasons athletes have performed such exercises in the warm up. As a coach you want the athlete to work opposing muscle groups together actively in the warm up to optimise performance in the training or competition to follow. This is referred to as 'functional flexibility'. This is important because when an athlete performs a movement, especially a speed movement, the muscles required to move the body or an implement in the desired direction must contract quickly. However, the opposing muscle must relax equally as quickly for optimum performance. The functional flexibility needed is activated through an active, dynamic warm-up, using appropriate mobilisation exercises. Traditional static stretches do not provide this functional flexibility and may actually 'put the muscle to sleep' – something you definitely do not want in the warm up. Some examples of active, dynamic mobilisation exercises are shown below.

Examples of active, dynamic mobilisation exercises

FLEXIBILITY TO INCREASE THE ROM

There are times when an athlete has a limited ROM at a joint or a series of joints and needs to work on improving this. Whenever an athlete does flexibility work to increase the range of motion you want the selected muscle or muscle group that are stretched to relax and so enhance the range of motion. This protects not only the muscle but also the joint or joints involved with a specific muscle group. If athletes execute a passive stretch until they feel discomfort, it means that pain receptors in the area being stretched are being triggered and the body is telling the brain something is not right. An athlete should not feel discomfort or pain during flexibility training.

Improving flexibility, like the development of other fitness abilities, is a slow process. To increase the range of motion of a joint the muscles have to be stretched beyond their normal point of resistance and the stretch held for a period of 15-30 seconds. The duration of holding the stretch will vary according to the stretch being used and the fitness of the athlete. This should be done several times a week with appropriate flexibility exercises. There are two main types of stretching exercise:

- Active stretching
- Passive stretching

In active stretching the athlete controls the movement. These exercises are usually done in the 'end position', as a static exercise and these can be used in the cool down, for 6-10 seconds to regain any ROM 'lost' during the session. If the active, static stretch is to increase the ROM in a separate flexibility session, the stretches are held for 15-30 seconds.

Examples of active, static stretching exercises

In passive stretching the exercises are only performed in the end position, the static type of exercise. A partner controls the movement and great care is required. The athlete actively goes to the end position and the partner progressively applies pressure. At this point the athlete should concentrate on relaxing the muscles being stretched. Passive static stretching exercises can produce good improvements in range of motion provided the individual controlling the stretching is skilled in this type of stretching.

Example of a passive, static stretching exercise

Sample Mobilisation Exercises for the Warm Up

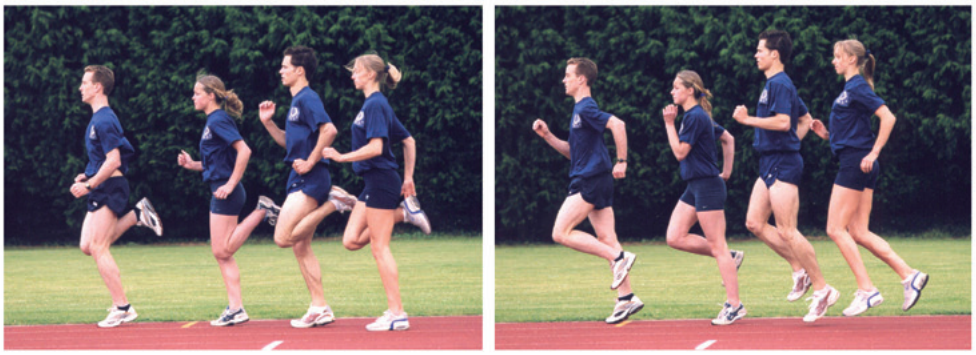
Slow to Fast ***Active to Dynamic*** ***General to Specific***

ARM CIRCLES

Either standing upright or while walking, circle one arm clockwise and the other arm counter-clockwise. Alternate direction.

LEG SWINGS

Standing side-on to a hurdle or something similar, place hand on the hurdle for support and swing the outside leg forwards and backwards – flexing and extending the leg/hip and keeping the pelvis 'neutral'. Repeat for other legs. Another exercise can be done with body facing the bar, swinging leg to the side away from and across the body – adducting and abducting the leg/hip.



HEEL FLICKS

Small running steps, athlete quickly picks "toe up – heel up" behind them close to the body – ankle is 'cocked'.

WALKING LUNGES

Long strides, high knee raises into low lunge position, feet always facing forwards, rear knee down towards the ground, front knee at approximately 90 degrees or less. Alternate arm and leg action.

Sample Mobilisation Exercises for the Warm Up

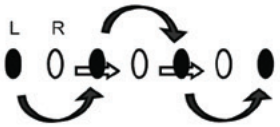
Slow to Fast ***Active to Dynamic*** ***General to Specific***

SKIPPING

SIDE STEPS

CARIOCA

Facing sideways, travelling to the right, left foot goes in front of right, right foot goes to the right, left foot goes behind right and then right foot goes to the right.



BACK SLAPS

Walking or skipping - stretch arms out to the side at shoulder height and then swing arms across body to slap the back. Alternate right on top, right underneath

Sample Stretching Exercises for Increase of ROM

For the cool down or as a separate session for improving flexibility

CALF STRETCHES

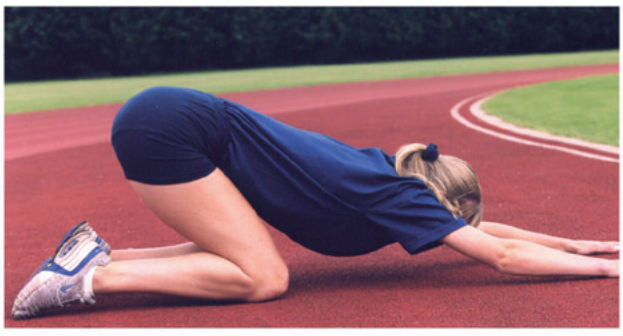
ADDUCTOR STRETCH

QUADRICEPS STRETCH

IT BAND STRETCH

HAMSTRING STRETCH

SHOULDER STRETCH



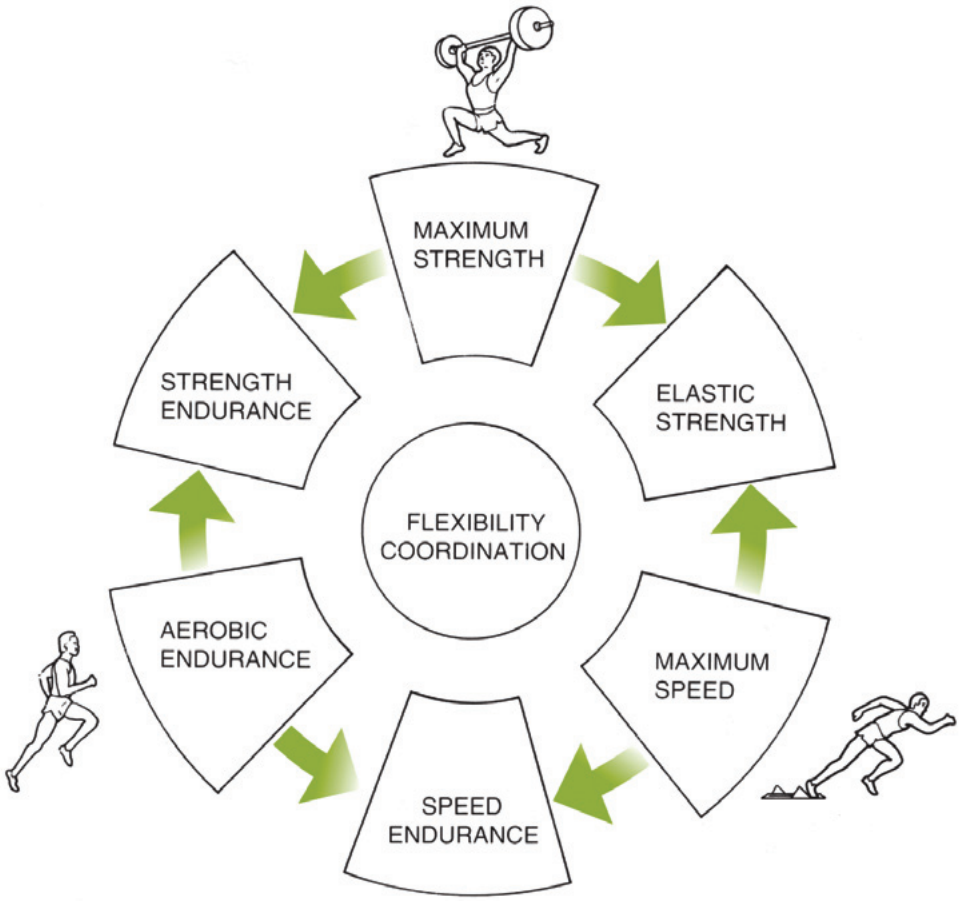
Stretching exercises in the cool down:
hold for 6 -10 seconds

Stretching exercises in a flexibility session:
hold for 15 -30 seconds

DEVELOPING COORDINATION

Coordination is the ability to carry out complicated movements such as those involving more than one sequence or body part at the same time. It is the ability to carry these movements out at the optimal speed, efficiently and accurately. It is considered that an athlete with good coordination is capable not only of performing a skill well but also of rapidly solving a training task or learning a new skill. Coordination is one of the elements of 'physical literacy' developed in the Fundamentals stage and, in many ways, is required before a child can develop the other elements, which together make up physical literacy. For adults taking up running for the first time without a background in another sport or returning to running these basic skills may be dormant or not developed. This will affect their successful development if not addressed as part of their training.

The coordination required for walking and running can be developed from a young age once the nervous system is mature enough. Girls between the ages of 8 and 11 and boys between the ages of 8 and 13 have exceptional rates of learning in the skill 'window of opportunity'. Basic coordination exercises and skills should be continued into the Foundation stage to become the foundation for later event specific skill development. In the mature athlete coordination exercises and drills remain important as they maintain a balance against the imbalances caused by very specific training. Coordination may be affected in runners with impairments such as cerebral palsy. The extent of this will of course vary between athletes and should be discussed with them directly. As with all athletes it should of course still be addressed as part of their training.



Inter-relationship of the components of fitness

In summary, the components of fitness have been presented separately to identify the characteristics of each. In practice there is no such thing as a 'pure' strength exercise or a 'pure' speed exercise. The components of fitness contribute to overall physical fitness and an understanding of their inter-relationship allows the coach to plan training more effectively.

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