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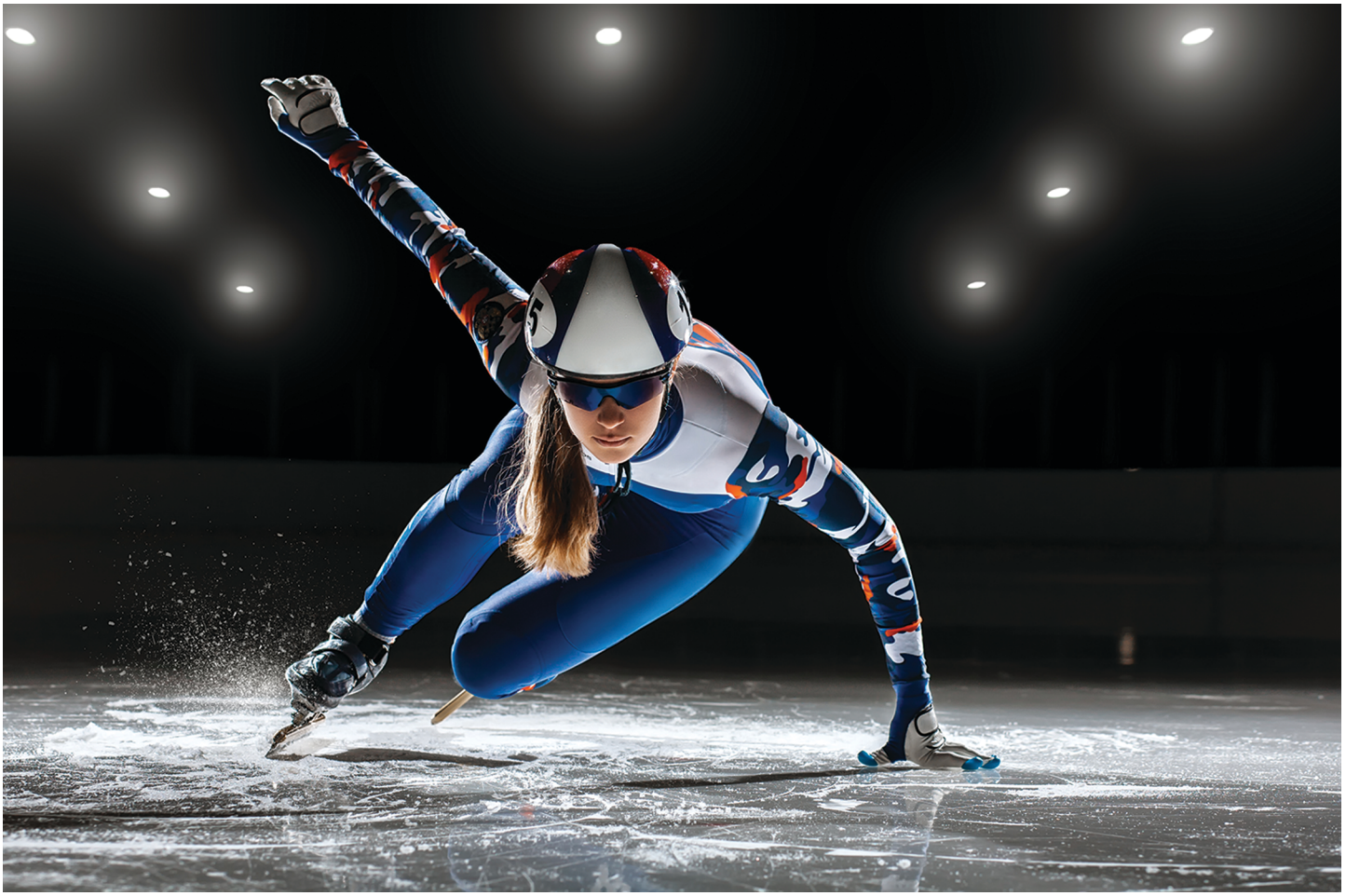
Training for speed and power in sport and fitness



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Introduction

Introduction

Welcome to this free course in which you will explore training for speed and power in relation to sport and fitness. Speed and power are separate but closely related components of fitness that are important in a wide range of sports and activities. First, you will consider the mechanics and physiology of speed before looking at training methods to develop speed. You will follow a similar structure in the second half of the course where you will examine the mechanics and physiology of power, then look at training to develop power.

This OpenLearn course is an adapted extract from the Open University course E236 *Applying sport and exercise sciences to coaching*.

Learning outcomes

After studying this course, you should be able to:

- explain what is meant by the concepts of speed and power
- understand the physiological principles that underpin speed and power
- apply a range of training techniques for speed and power in practice.

1 What are speed and power?

Before you can look at how to train for speed and power you need to understand the definitions, mechanics and physiology of these components of fitness. In Activity 1 you will start by exploring speed and power.

Activity 1 What are speed and power?

Allow 10 minutes for this activity

Watch Video 1 and then reflect on what the words ‘speed’ and ‘power’ mean to you.

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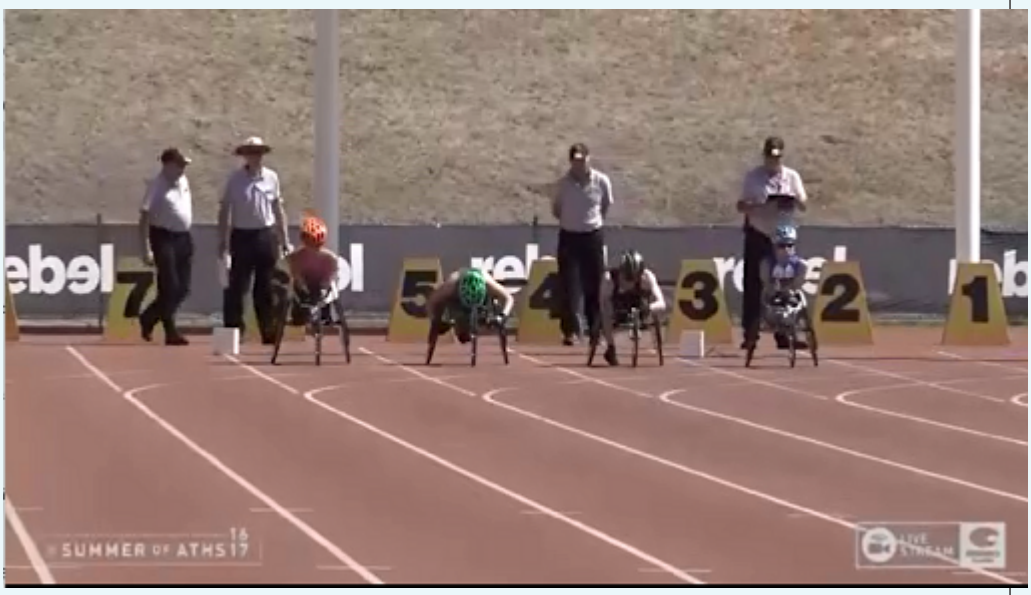
Video 1 Speed and power



Now answer the following questions and write them in the box below.

- What is speed?
- What is power?
- What sports/activities require speed and power?

Provide your answer...

Discussion

Speed can be defined as a measure of the rate of motion and is therefore the distance travelled divided by the time taken to travel that distance (Murray and Kenny, 2016). Power is a measure of the rate at which energy is transferred – that is, power is force multiplied by distance divided by time (Murray and Kenny, 2016). So in simple terms speed refers to how quickly we move (for example, from the start to the end of a 100m race), while power is a combination of strength and speed, and refers to the ability to execute strong explosive movement at a fast pace (for

instance, as with exploding from the starting blocks). Speed and power are closely related, and both are often important in specific sports or activities.

A needs analysis of your sport or activity will indicate how important speed and power are to you. There is a wide range of sports and activities in which speed and power are important – in some sports such as sprinting or power-lifting, achieving speed and power are the main objectives, whereas in other sports such as rugby or football they are just one aspect of the sport. Speed or power may be required in various parts of the body – for example, in cricket the arm of a bowler needs to be able to travel at speed to deliver the ball, but the legs and the rest of the body also need to move fast in order to enable this.

Hence training to develop speed and power needs to consider the movements involved in partaking in the sport. You will now consider this: the mechanics and physiology of speed.

2 Speed

Figure 1

In simple terms, speed refers to how quickly an athlete moves. This may relate to movement of the entire body itself from start to finish over a specific distance (as in a 50m sprint swim) or to how quickly an athlete can move a body part (as in throwing a rapid punch in boxing). Speed is also related to the component of agility, when one quickly changes direction (as in making a rapid turn to avoid an opponent in hockey). In the next section you will further your understanding of speed by exploring biomechanical principles.

2.1 The mechanics of speed

In this section you will investigate the biomechanics of speed in order to buttress your understanding of speed and how to develop it.

Activity 2 Speed mechanics

Allow 40 minutes for this activity

Watch Video 2 and have a look at the glossary below in Box 1. Once you've watched Video 2 and completed the reading, fill in the gaps in the statements below which describe how these terms can be applied to a sprinter at the start of a race.

Video content is not available in this format.
Video 2 The science of sprinting

Box 1 Glossary of speed terms

- Velocity: How fast an object (or person) is moving and its direction
- Speed: The rate at which an object (or person) covers a distance
- Impulse: The product of the force generated, and the time required to produce the force (force x time)
- Force: The product of mass and acceleration or a push/pull exerted on one object by another
- Acceleration: The rate at which an object's velocity changes over time

Use the drop-down menus to select the correct missing word.

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Having explored the biomechanical principles of speed you will now look at the physiology of speed and how this relates to speed training.

2.2 The physiology of speed

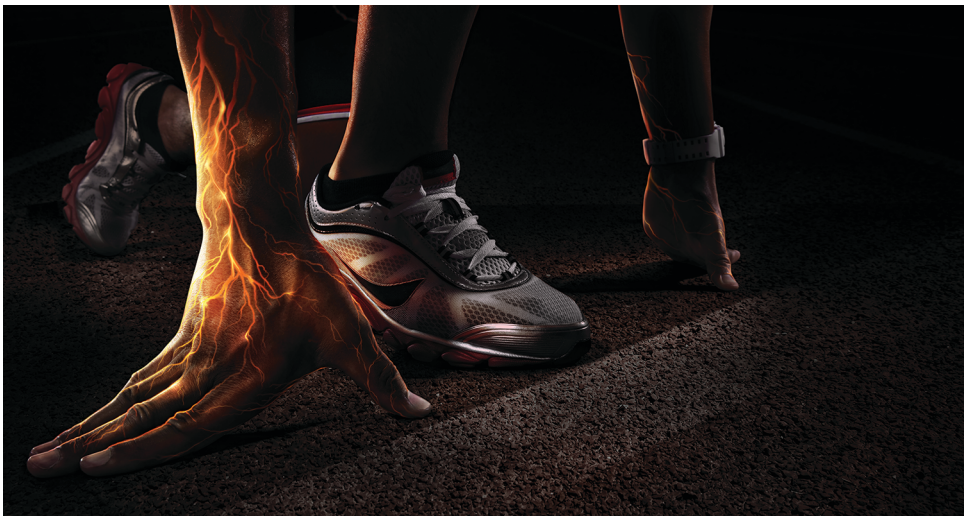

Figure 2

An athlete's neuromuscular system is vital to sprint performance because it can influence the rate and strength of muscle contraction. Having a greater understanding of the neuromuscular system is important to identify its contribution to speed and its opportunity for development. An overview of the neuromuscular contributions to speed are shown in Table 1.

Table 1 Neurophysiological basis for speed

System/ Section	Key learning points and application to a sprinter
Muscular system	The composition of muscle fibre types (i.e. amount of Type 1, IIa and IIx fibres) can dictate speed performance (Jeffreys, 2013). Those with a relatively higher proportion of fast-twitch fibres (Type IIa and Type IIx) have a greater capacity to produce force and develop speed. While there is a major genetic component underlying whatever proportion of fast- and slow-twitch muscle fibres particular individuals may have, training may also have an effect. For example, endurance training may lead to Type IIa fibres taking on the aerobic characteristics of Type I fibres, reducing the force capacity of the muscle and the ability to generate speed (Jeffreys, 2013).
Nervous system	Sprint training will lead to several adaptations in her neuromuscular system, such as an enhanced neural drive (rate and amplitude of impulses being sent from the nervous system to her muscles). Increases in neural drive may contribute to increasing a sprinter's rate of force development and impulse generation, which as you saw in Activity 2 will improve sprinting performance.

This again links back to the principle of specificity: for a training programme to develop speed it needs to include exercises and/or activities that are performed at speed. To develop the neuromuscular system's contribution to power, heavy weight training and

plyometric exercise can be used to develop the capacity of fast twitch muscle fibres and enhance neural drive.

Now that you've considered how the physiology of speed may influence training methods used to develop speed, you can move on to look at the application of speed training methods by the strength and conditioning coach.

2.3 Developing speed: methods

Figure 3

After gaining an understanding of the biomechanics and physiology of speed, you can now turn your attention to the training methods that may be used to develop speed. Plisk (2008) identifies three methods for developing speed: primary, secondary and tertiary methods.

1. **Primary methods** focus on executing sound movement technique in a specific task. Initially primary methods of developing speed tend to be performed at speeds slower than those used in the real situation to ensure that the mechanics of the movement are correct, progressing to full speed as the individual develops their skills (for example, with a high knee drill).
2. **Secondary methods** involve developing specialist skills in modified conditions and include sprint resistance and sprint assistance methods.
    a. **Speed resistance** methods aim to provide resistance without interrupting movement mechanics. This resistance may come from physical resistance (as with running while pulling a sled or with a parachute).
    b. **Speed assistance** methods aim to facilitate movements at a faster speed than normal ('over-speed') and include downhill running and running while being towed.
3. **Tertiary methods** involve developing general skills and abilities and include the development of mobility (as with a dynamic lunge with rotation), strength (as with resistance training) and speed-endurance (as with interval training).

2.4 Speed training in action

In Activity 3 you will watch a short video of speed training in action which will help you consider how a strength and conditioning coach could use different methods with athletes.

Activity 3 Speed training in action

Allow 30 minutes for this activity

Watch Video 3, in which strength and conditioning coach Fiona Scott at the University of Hertfordshire, UK, leads a speed training session for some university athletes and students.

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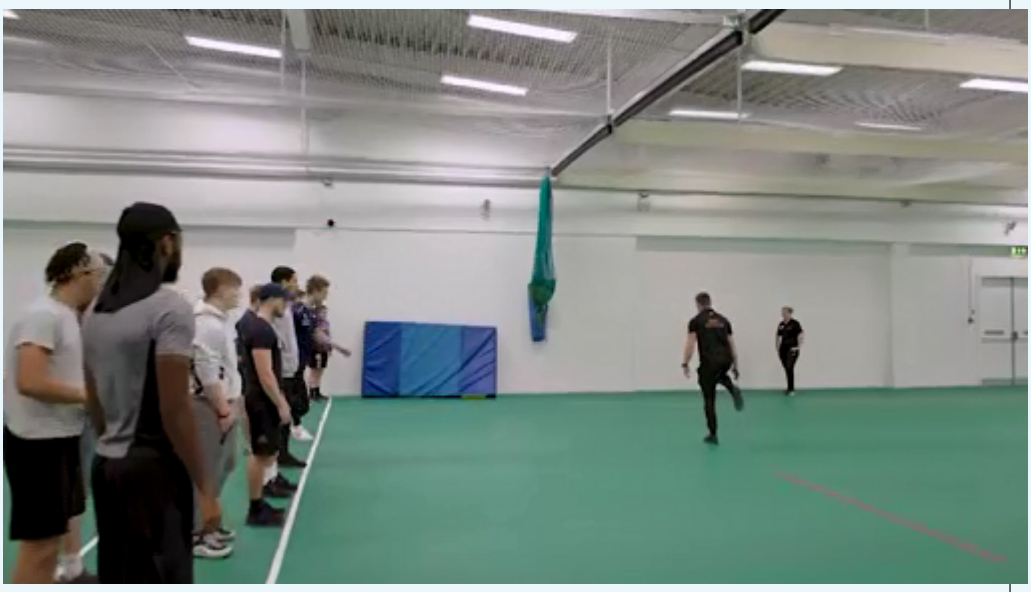
Video 3 Fiona Scott: speed training



Now answer the following questions:

1. What information does the strength and conditioning coach gather to plan speed training sessions?
2. What speed training activities are being performed by the athletes and to what extent are they specific to the demands of the sport?
3. How does the strength and conditioning coach progress speed training exercises?

Provide your answer...

Discussion

1. Before planning speed sessions, Fiona the strength and conditioning coach will talk to the athlete to confirm their training age and injury history. Then Fiona will

perform a needs analysis of both the athlete and their sport to determine the biomechanical, physiological and injury prevention needs.

2. In Video 3 you see the coach deliver speed drills (primary method), resistance-band acceleration (secondary method), and plyometric training. Speed resistance and assistance training methods could be useful to any individual who needed to develop speed and therefore could be utilised by individuals from a range of sports. As always, the training principle of specificity should be considered when identifying appropriate speed training exercises. The examples in Video 3 are all running-based and would therefore be appropriate for individuals who wish to develop their running speed (such as sprinters, footballer players, rugby players). Alternative exercises would be more appropriate for those who needed to develop speed in other movements (such as throwers, bowlers, swimmers). For example, L'ubos *et al*. (2018) found that swimming training with a parachute (speed resistance) improved swimming speed.
3. Speed training can be progressed by increasing the volume (the demand that the athlete places on their body), load (resist movement or increase height in plyometrics) or frequency (number of sessions per week) of training.

Speed resistance training, as with the resistance-band sprinting you saw in Video 3, is hypothesised to have various benefits (for example, improving acceleration), but if the loads are not appropriate for the individual that may overly affect the mechanics of running (DeWeese and Nimphuis, 2016). Considerable research has been done on speed resistance training. For example, in a review of the literature Alcaraz *et al*. (2018) concluded that resisted sled training is an effective method of improving sprint performance. However, there is limited research evidence to support the use of speed assistance and it can lead to negative effects such as an increase in braking forces (DeWeese and Nimphuis, 2016). The strength and conditioning coach should consider the robustness of research evidence supporting whatever methods they use with their athletes.

Having looked at speed training, you will now consider power.

3 Power

Figure 4

Power is closely related to two components of fitness: strength and speed. Power is effectively the product of strength and speed (Faigenbaum, 2017) and is the ability to execute strong explosive movement at speed. As such, speed, strength and power are often jointly identified in needs analyses as key components of fitness in certain sports and/or activities (such as rugby, weightlifting, sprinting or hammer-throwing).

In this section you will primarily be considering two power training methods (plyometric training and weight training) and the science behind them. Plyometric training refers to explosive jump training that involves fast, powerful movements that are preceded by a stretch or countermovement (Potach and Chu, 2016). Before you consider these power training methods in detail you need to look at the physiology and biomechanics involved.

3.1 Power training: physiology and mechanics

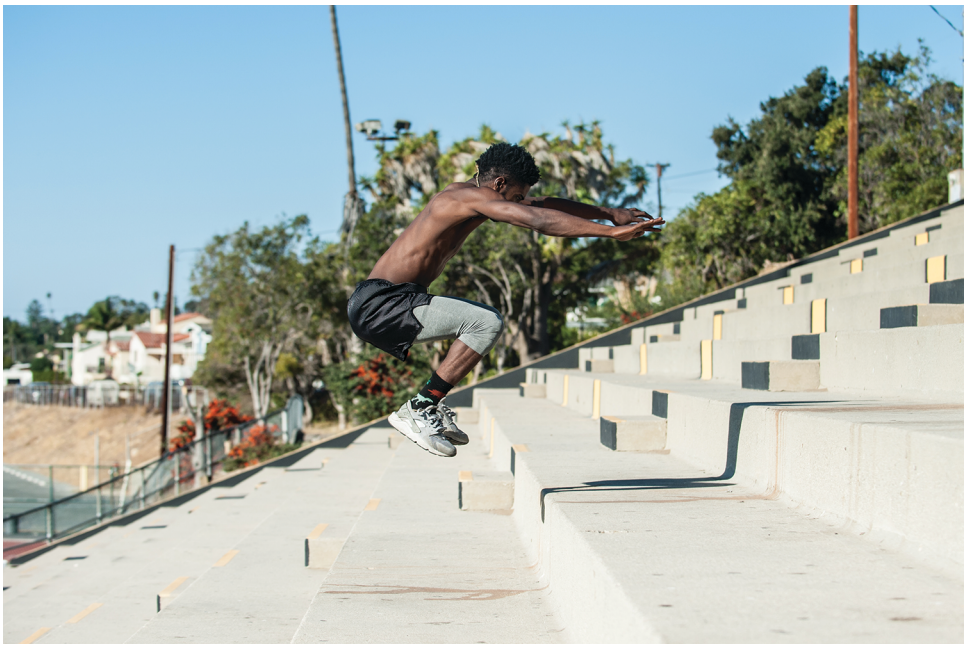


Figure 5

When a muscle is stretched rapidly, the neuromuscular system responds by initiating a concentric muscle contraction to prevent the muscle from being stretched too far and becoming damaged. This is known as the stretch-reflex system. In plyometrics, this means that if a rapid eccentric loading phase is performed before a concentric contraction, a greater and more powerful concentric muscle action will occur. This 'pre-stretch' action is known as the stretch shortening cycle and is explained further in Activity 4.

Activity 4 Plyometric mechanics and physiology

Allow 40 minutes for this activity

Watch Video 4, on the stretch-shortening cycle, at the link below. Focus on the section between the start and 02:55. Once you've watched Video 4, do the related tasks below.

Video 4: The stretch-shortening cycle

1. Use the drop-down menus to select the correct missing word.

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2. Put the three phases of the stretch-shortening cycle in the order they are performed.

Eccentric

Amortisation

Concentric

Match each of the items above to an item below.

First

Second

Third

Now that you have an understanding of how plyometric training works, in the next section you will investigate some examples of plyometric training.

3.2 Developing power: plyometric training

Figure 6

Various studies have found plyometric training to be effective in developing power and improving performance (Stojanović *et al.*, 2017). A wide range of plyometric exercises may be employed to develop power. Potach and Chu (2016) divide these into lower-body, upper-body and trunk exercises. The choice of exercises should depend on various

factors, including the unique requirements of the individual (needs analysis), their age and fitness levels. You will consider some examples of plyometric exercises in Activity 5.

Activity 5 Plyometric training in action

Allow 30 minutes for this activity

Watch Video 5, in which a range of plyometric exercises are demonstrated. Then select one exercise that you think would be most appropriate to use with a 200m sprinter and explain why you selected this particular exercise.

Video content is not available in this format.
Video 5 Plyometric exercises

Provide your answer...

Discussion

You probably chose your exercise by applying the principle of specificity. In other words, you probably tried to select an exercise that would be relevant to a 200m sprinter. Any of the lower body plyometric exercises with similar movement patterns (i.e. in a sagittal plane), or that work the muscle groups that a 200m sprinter needs to develop (i.e. quadriceps, hamstrings, gastrocnemius) in order to improve her sprint performance would be beneficial.

Plyometric training provides an effective way to develop functional power and enables the strength and conditioning coach to prescribe functional exercises for the athlete which are specific to that athlete's sport. In the early training of plyometrics, developing proper technique and balance must be prioritised to minimise the injury risk of the high intensity

exercise. In the next section you will look at another method of developing power: weight training.

3.3 Developing power: weight training

Figure 7

In strength and conditioning, it is important to prescribe the correct intensity/load (i.e. % of repetition maximum (RM), number of repetitions, sets and amount of rest in relation to the training goal to gain maximum results). Table 2 shows that for power, high load and relatively few repetitions are recommended.

Table 2 Training principle recommendations for training goals

Training goal		Load (% of 1RM)	**Repetitions**	**Sets**	**Rest**
Maximal strength		≥ 85	≤ 6	2–6	2–5 minutes
Power	single-effort event	80–90	1–2	3–5	2–5 minutes
	multiple-effort event	75–85	3–5		
Hypertrophy		67–85	6–12	3–6	30–90 seconds
Muscular endurance		≤ 67	≥ 12	2–3	≤ 30 seconds

Source: Sheppard and Triplett (2016)

A single-effort event is where one maximum-power effort is required (i.e. shot put, high jump, power lifting). A multiple-effort event is one where repeated maximum-power efforts are required (i.e. rugby, volleyball).

For power, the type of exercise is also important to achieve training goals. In this section you will consider some examples of weight-lifting exercises that are suitable for developing power. As you would expect, given the definition of power, such exercises involve fast, explosive movements; you will investigate some of these in Activity 6.

Activity 6 Being explosive in the gym

Allow 10 minutes for this activity

Watch Video 6 in which you will see several weight-lifting exercises designed to develop power. Which exercises would be most appropriate for developing explosive leg power? Watch from 02:32 (‘Once you have a basis of strength …’) to 03:35 (‘… high-velocity power output movement’).

Video 6: Weight-lifting to develop power

Provide your answer...

Discussion

In Video 6 you see a variety of exercises being performed, including power cleans, power snatch and squat jumps. What all these exercises have in common is that they’re performed with fast, explosive or jumping movements – so they differ from more traditional weightlifting exercises which tend to be performed more slowly. Explosive exercises require relatively more technical input from a qualified strength and conditioning coach. Weight training exercises to develop power include Olympic lifts (such as snatch, clean and jerk). Squat jumps, the snatch and the clean are very effective at developing explosive leg power for sprinting.

4 End-of-course quiz

You can now take part in a quiz which is an opportunity to check your learning of some of the main points addressed in this course.

End-of-course quiz

Which two components of fitness create power?

- ☐ a) Muscular endurance x strength
- ☐ b) Cardiovascular endurance x speed
- ☐ c) Strength x speed
- ☐ d) Anaerobic capacity x agility

What are the two main training methods for developing power?

- ☐ a) Plyometric and balance training
- ☐ b) Plyometric and weight training
- ☐ c) Plyometric and endurance training
- ☐ d) Plyometric and core training

In the stretch shortening cycle, which type of muscle contraction is required initially to create elastic energy?

- ☐ a) Concentric contraction
- ☐ b) Eccentric contraction
- ☐ c) Isometric contraction
- ☐ d) Isokinetic contraction

Which of the following is a speed resistance method of speed training?

- ☐ a) Running downhill
- ☐ b) Running while being towed
- ☐ c) Running with a parachute
- ☐ d) All of the above

What are the optimal training load, repetitions, sets and rest periods to develop power?

- ☐ a) ≥85% of 1RM, 1–6 repetitions, 2–6 sets, 2–5 minutes rest between sets
- ☐ b) 75–90% of 1RM, 1–5 repetitions, 3–5 sets, 2–5 minutes rest between sets
- ☐ c) 67–85% of 1RM, 6–12 repetitions, 3–6 sets, 30–90 seconds rest between sets
- ☐ d) ≤67% of 1RM, ≥12 repetitions, 2–3 sets, ≤30 seconds rest between sets

Conclusion

In this course you've investigated speed and power in relation to sport and fitness. The key learning points from the course are that:

- speed and power are key components of fitness in a range of sports and activities
- in simple terms, speed relates to how quickly we move, while power is a combination of strength and speed
- in order to design effective training programmes, you need to understand the mechanics and physiology of speed and power
- speed training methods include speed resistance methods (as with sled-pulling) and speed assistance methods (as with downhill running)
- power training methods include plyometrics and Olympic lifts.

This OpenLearn course is an adapted extract from the Open University course E236 *Applying sport and exercise sciences to coaching*.

You might interested in another OpenLearn course taken from this Open University course: *Training for endurance in sport and fitness*.

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Acknowledgements

This free course was written by Simon Penn, Caroline Heaney and Nigel Wright.

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