TOPIC 11
Sports medicine

OVERVIEW
11.1 Classifying and magnifying sports injuries
11.2 Sports medicine and the demands of specific athletes
11.3 Preventative action — Enhancing the well-being of the athlete
11.4 Managing injury rehabilitation
11.5 Topic review

OUTCOMES
In this topic students will:
- explain how a variety of training approaches and other interventions enhance performance and safety in physical activity (H8)
- select and apply strategies for the management of injuries and the promotion of safety in sport and physical activity (H13)
- devise methods of gathering, interpreting and communicating information about health and physical activity concepts (H16)
- select appropriate options and formulate strategies based on a critical analysis of the factors that affect performance and safe participation. (H17)
11.1 Classifying and managing sports injuries

CRITICAL QUESTION
How are sports injuries classified and managed?

Most of us are familiar with sports injuries of one kind or another. Being able to correctly identify the type of injury and administer or advise on proper treatment lays the foundation for a quick recovery.

11.1.1 Ways to classify sports injuries

Injuries are a part of sport. They occur more frequently in contact sports such as football, but may be the result of overuse caused by repetitive movements experienced in activities such as running.

Sports injuries are usually classified according to their cause. The most common classification is to identify injuries as direct, indirect, soft tissue, hard tissue and overuse injuries.

Direct and indirect injuries

Some injuries are caused by direct forces generated from outside the body. Direct injuries result in fractures, dislocations, sprains and bruises. A shoulder dislocation caused by a tackle in football or a broken bone caused as a result of a collision between hockey players are examples of direct injuries.

In contrast to direct injuries, indirect injuries are caused by an intrinsic force; that is, a force within the body. Indirect injuries normally occur as a result of inadequate warm-up, ballistic movements, excessive movement, or a fault in the execution of a skill. They are the result of excessive strain being placed on muscles, tendons and ligaments, causing irritation and possible damage to body structures. Examples of indirect injuries include a sprinter tearing a hamstring muscle during a race, or a volleyball player causing stress to ligaments in the knee joint (see figure 11.3).
Soft and hard tissue injuries

**Soft tissue injuries** include damage to muscle, tendons, ligaments, cartilage, skin, blood vessels, organs and nerves. There are many types of soft tissue injury. They may be *acute* (occurring suddenly, such as a sprain) or *chronic* (prolonged). Acute soft tissue injuries include sprains, strains, dislocation, subluxation, torn cartilage, contusions and abrasions. Prolonged soft tissue injuries may include many of the same types of injury, but their severity necessitates a long rehabilitation. Two of the most common soft tissue injuries are tears and contusions.

**Hard tissue injuries** cause damage to bones and teeth. They are frequently more serious than soft tissue injuries. Examples of hard tissue injuries include dislodging a tooth and fracturing a bone. The most common hard tissue injury is a *fracture*.

Like soft tissue, bone can also be traumatised by physical activity. However, because of its role as a structural support, hard tissue that has been injured must be carefully examined and correctly treated.

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**FIGURE 11.4** Achilles tendonitis is an example of a soft tissue injury.

**FIGURE 11.5** Hard tissue injuries are serious, many causing severe pain and discomfort.

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**Overuse injuries**

**Overuse injuries** result from intense or unreasonable use of joints or body areas. They are provoked by repetitive, low-impact exercise such as jogging or stepping. These injuries cause pain and inflammation around the site of the injury. Typical overuse injuries include anterior shin splints (an irritation to the front portion of the shinbone; see figure 11.6) and tendonitis (irritation of tendons; for example, in the Achilles tendon in the heel).

Overuse often contributes to **stress fractures** that may be difficult to detect in the early stages. Stress fractures are small incomplete bone fractures caused by repeated pounding, usually on hard surfaces. Local swelling and tenderness may indicate a stress fracture. These should be initially treated using the RICER method but ultimately prolonged rest may be necessary for full recovery.

**FIGURE 11.6** Shin splints and stress fractures are common types of overuse injury.
Application
Classifying sports injuries

1. Read the following scenarios and classify them according to the type of injury most likely to have occurred in each case. Place each letter into the appropriate space in a grid like the one below.

(a) A cricketer begins to run between the wickets and feels a sharp pain in the calf.
(b) A gymnast completes a routine on the parallel bars but lands heavily and twists her ankle.
(c) A baseball player misses a catch and the ball hits his front teeth.
(d) A long distance freestyle swimmer feels discomfort in the shoulder 1200 metres into a race.
(e) A hockey player hears a crack as her shoulder collides with an opposing player's head.

<table>
<thead>
<tr>
<th>Hard tissue</th>
<th>Soft tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td></td>
</tr>
<tr>
<td>Indirect</td>
<td></td>
</tr>
<tr>
<td>Overuse</td>
<td></td>
</tr>
</tbody>
</table>

2. With a partner, think of five other injury scenarios and classify them in the same way.

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11.1.2 Soft tissue injuries
Tears, sprains and contusions occur frequently in sport and differ according to the type of damage caused to internal structures.

**Tears, sprains and contusions**

A tear occurs when tissue is excessively stretched or severed. Two types of tear are sprains and strains.

**Sprains** arise from the stretching or tearing of a ligament. These are strong, rigid and relatively inelastic tissue. Their role is to connect bone to bone, thereby providing joint stability. Sprains happen when ligaments are stretched or torn, resulting in pain, swelling and the inability to perform normal joint movements. Proper rehabilitation management techniques are recommended, as healing in the stretched position causes permanent instability in the joint. Healing is a slow process because ligaments have a relatively poor blood supply. Sprains can be classified according to the severity of ligament damage. The classifications are illustrated in figure 11.7.
**Sprains** occur only in ligaments and are graded according to severity.

- **First degree** — little damage
- **Second degree** — moderate damage
- **Third degree** — extensive damage

**Strains** occur when a muscle or tendon is stretched or torn. They cause considerable pain and bleeding may cause discolouration around the injury. Any movement in the form of stretching and any pressure on or around the injury will result in sharp pain.

There are three levels of strains; these are illustrated in figure 11.8.

Impact with a player or object sometimes causes a **contusion**, or bruise. Contusions vary in intensity. Some are superficial, remaining close to the skin. However, others penetrate deeply, causing bone to bruise. Contusions interrupt blood flow to surrounding tissue. When this occurs, a **haematoma** (blood tumour) forms as the blood clots in the connective tissue membrane. Internal bleeding into the area may continue for a period of time. A typical contusion is illustrated in figure 11.9.
Skin abrasions, lacerations and blisters

Abrasions, lacerations and blisters are forms of skin trauma. They are caused by the application of force, such as scraping or friction to the outer layer of skin. They can cause concern and considerable discomfort.

Skin abrasions

Abrasions occur in games such as netball or tennis, where a player may fall on a dry, hard surface. The injury causes pain and shallow bleeding as a result of the skin being scraped. The skinned area may be embedded with dirt and foreign materials. Treatment requires gentle cleansing and sterilisation of the wound to prevent infection.

Lacerations

A laceration is a wound where the flesh has incurred an irregular tear. Particular care must be taken to prevent infection. Lacerations can occur to the scalp and mouth, particularly the lips and tongue if the soft tissue has been forced against the teeth. In the event of a scalp laceration, as illustrated in figure 11.11, the area needs to be thoroughly cleansed with antiseptic soap, dried and a sterile gauze pad applied. Pressure may still need to be applied to prevent bleeding. Lacerations longer than one centimetre need to be referred to a doctor. Mouth lacerations require a thorough inspection to ensure there is no further damage, such as dislodged teeth. The mouth can be rinsed with an antiseptic liquid. Sucking on ice assists in the control of bleeding and swelling.

Blisters

Blisters are caused by a collection of fluid below or within the epidermal (surface) layer of the skin giving rise to intense pain. Blisters can contain clear liquid or even blood if a blood vessel has been ruptured. Blisters occur when:

- new equipment is being worn or used
- equipment is used for a long time, which may happen with clubs, bats or racquets
- the activity requires sudden changes of direction, causing friction in a sports shoe.

Management initially requires rest for 24 hours, when the symptoms may disappear. However, if the fluid in the blister is still present and causing concern, it may need to be surgically released and a donut pad applied. In the case of torn blisters or where the skin has been worn away, injury management requires the area be washed with soap and warm water and liquid antiseptic be applied. The area should be dried and antibiotic ointment applied. Use of ‘second skin’ dressing will aid the healing process.

Application

Identifying sports injuries

Complete the table by identifying the type of injury from the following list and inserting it in the appropriate space.
Inflammatory response

When soft tissue is injured, it becomes inflamed but responds by activating a self-healing process. This is referred to as the inflammatory response and may last up to three or four days after the injury occurs, depending on the extent of the damage. The injury will progress through the following phases as part of the healing process.

Phase 1, the inflammatory stage, is characterised by:
- pain, redness and swelling around the injured area
- loss of function and mobility
- damage to cells and surrounding tissues
- increased blood flow to the area
- leakage of fluid causing swelling (oedema)
- the formation of many blood vessels to promote healing.

Phase 2, the repair and regenerative stage, may last from three days to six weeks. It is characterised by:
- the elimination of debris
- the formation of new fibres
- production of scar tissue.

Phase 3, the remodelling stage, can last from six weeks to many months. It is characterised by:
- increased production of scar tissue
- replacement tissue that needs to strengthen and develop in the direction that the force is applied. The type of remodelling varies according to the timing and degree of mobilisation of the injury. Excessive exercise too early causes further damage. Too little exercise allows large quantities of scar tissue to form, which lacks strength and flexibility.

Immediate treatment of soft tissue injuries aims to reduce swelling, prevent further damage and ease pain. In the long term, treatment aims to:
- restore flexibility
- regain full function
- prevent recurrence
- return the player to the field as soon as possible.

Management of soft tissue injuries requires application of the RICER principle. RICER is an acronym that stands for rest, ice, compression, elevation and referral.

Properly used, the RICER method, which is explained fully in table 11.1, ensures that the injury heals correctly and in the shortest period of time. If RICER is not used, the injury takes longer to repair and has less strength and flexibility. This is illustrated in figure 11.12.
TABLE 11.1 The RICER method

<table>
<thead>
<tr>
<th>RICER</th>
<th>Why</th>
<th>How</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>R Rest</td>
<td>To reduce bleeding into the injury and prevent further injury</td>
<td>Place in a comfortable position with the injury elevated and supported.</td>
<td>Until beginning a program of careful mobilisation</td>
</tr>
<tr>
<td>I Ice</td>
<td>To reduce: pain, blood flow, swelling, spasm, enzyme activity, tissue demand for oxygen</td>
<td>• Crush ice in a wet towel and wrap around the injury, or • apply frozen gel packs using a towel as an insulator (as frozen gel is colder than ice), or • immerse the injured area in a bucket of iced water (Note: insulating material, such as towels, prevents possible tissue damage from overexposure to cold.)</td>
<td>20 minutes every hour up to four days</td>
</tr>
<tr>
<td>C Compression</td>
<td>• Decreases bleeding • Reduces swelling</td>
<td>Wrap an elastic bandage over the injured area, covering both above and below the site.</td>
<td>At the time of the injury and reapplied periodically for at least 24 hours</td>
</tr>
<tr>
<td>E Elevation</td>
<td>• Decreases bleeding • Reduces swelling • Reduces throbbing</td>
<td>Raise the injured area above the level of the heart by placing a support (e.g. pillow) under the injury.</td>
<td>Whenever possible during the day and for the following two or three nights</td>
</tr>
<tr>
<td>R Referral</td>
<td>• To understand the nature and extent of the injury • To seek guidance in a program of rehabilitation</td>
<td>Appointment with a doctor or physiotherapist.</td>
<td>As soon as possible following the injury</td>
</tr>
</tbody>
</table>

FIGURE 11.12 Difference in injury repair when RICER is used and not used
To ensure effective rehabilitation, it is important to remember that:

- **rest needs to be active.** Rest does not imply lack of physical work for all parts of the body. During rest, it is important to maintain physical condition (for example, through swimming) and to begin mobilisation of the injured part as soon as possible. Soft tissue injuries should not be strapped for long periods of time as this promotes clotting.
- **ice should not be applied to cuts and badly damaged skin** as this reduces blood supply (which provides nutrition) to the area.
- **ice should remain on soft tissue until it begins to feel numb** (about 20 minutes). There should always be padding, such as a towel, between ice and skin.

**Application**

**Managing soft tissue injuries**

For this application, you will need ice or a frozen gel pack, wet towel and bandage. Form groups of three and allocate the following roles: patient, first aider and observer. To begin, the patient chooses an injury from the following list: ankle sprain, calf muscle strain, thigh contusion, forearm strain and knee sprain. The first aider manages the injury while explaining to the observer how the procedures work. When concluded, swap roles and choose a different injury.

**Inquiry**

**Immediate treatment of skin injuries**

Sometimes an injury involves cuts (lacerations), skin scrapings (abrasions) and possibly punctures. The primary concern is to prevent infection. In each case, the wound needs to be cleansed with soap and warm water. Serious wounds require medical treatment and it may be necessary to have a tetanus injection. Injuries such as these should be cleansed, but not treated with antiseptic before referral. Minor wounds must be cleansed and an antiseptic cream or solution applied before they are covered with a dressing.

Examine the injury in the photograph. Use the information above to help explain how the injury should be managed. The **Abrasions** weblink in the Resources tab may also assist.

**on Resources**

Weblink: Abrasions
11.1.3 Hard tissue injuries

The two most common hard tissue injuries are fractures and dislocations.

Fractures

There are two broad classifications of fractures — simple and compound. In simple (closed) fractures, the bone breaks but remains underneath the skin, as shown in figure 11.14(a). In compound (open) fractures the bone breaks and protrudes through the skin, as shown in figure 11.14(b).

There are many different types of fracture. These include green-stick, comminuted, depressed, impacted, oblique, longitudinal, spiral, transverse and serrated. Some of these are illustrated in figure 11.15.

Management of fractures requires:
- use of DRSABCD
- controlling bleeding
- treating shock
- use of a splint
- and bandage to immobilise (restrict movement of) the area
- immediate medical assistance.

Most suspected fracture type injuries require medical attention. Generally, medical attention is required if:
- there is obvious deformity
- there is uncontrolled bleeding
- the casualty is unable to complete the TOTAPS regime (see 11.1.4).
Dislocation

Dislocation is the displacement of a bone at a joint. They cause pain and are apparent because of the deformity they cause. Technically a dislocation is not a hard tissue injury because, although the bone is displaced, it is not damaged. The real damage is to ligaments that have been stretched or ruptured. In a dislocation, the bone actually comes out of the joint and remains out until it is physically reinserted. Dislocations should not be put back in place except by a qualified practitioner, as more damage can occur if the placement is incorrect.

The common signs and symptoms of dislocation are:

- deformity and swelling
- pain and tenderness
- loss of function.

Finger dislocations occur most often in contact sports. If the finger is dislocated it usually looks as if it is out of its normal position. Management requires:

- securing with a splint to fully immobilise the injury
- ice, elevation and support using a bandage
- immediate medical attention.

When treating a dislocation, follow these guidelines.

- Never attempt to relocate the displaced bone as this might increase the damage.
- Seek medical attention.

Sometimes a bone might momentarily ‘pop out’ and quickly return to place. This is called a subluxation. Although it stretches the ligaments, it may not cause additional damage at the time. However, the joint will be vulnerable and require rehabilitation and, possibly, surgery. A subluxation is illustrated in figure 11.17.
Application
Classifying sports injuries
Use a table like the one below to summarise the ways to classify and manage sports injuries. An example has been done for you.

<table>
<thead>
<tr>
<th>Classification of injury</th>
<th>Example</th>
<th>Management</th>
</tr>
</thead>
</table>
| Direct                   | Fracture| - Immobilise  
- Terminate participation in game or activity  
- Seek medical assistance |

Inquiry
Management of hard tissue injuries
Investigate the correct management of hard tissue injuries and the possible use of immobilisation procedures. The Sports injuries weblink in the Resources tab may assist with your investigation.

Resources

Weblink: Sports injuries

studyon

Option 3 Question 1 Topic 2 Concept 4
Fractures Summary screen and practice questions

11.1.4 Assessment of injuries
TOTAPS is an acronym that stands for:
- talk
- observe
- touch
- active movement
- passive movement
- skills test.

It is used to assess the extent of injury to a player and determine whether or not the injured person can return to the field. If the player can complete all tasks required, they should be allowed to return to play.
However, if the player is unable to complete any one of the requirements, the player should be allowed to return to the field only after assessment from a qualified medical practitioner.

**TOTAPS**

To complete the TOTAPS regime, follow these steps.

**FIGURE 11.18** Steps in the TOTAPS regime

- **Talk.** Talk to the player to find out exactly what happened. This provides valuable information about the nature of the injury.
- **Observe.** Look at the injury and see if there are any obvious signs of swelling or deformity. The easiest way to assess if an area is swollen is to compare both sides of the body.
- **Touch.** Gently feel the injury for any sign of deformity or swelling and try to pinpoint the area of pain.
- **Active movement.** Ask the player to perform a range of joint movements such as flexion, extension and rotation. If these can be done without pain, then further assessment can proceed.
- **Passive movement.** The assessor physically mobilises the joint (flexion, extension, rotation) using a range of movements aimed at identifying painful areas and any instability in the joint.
- **Skills test.** In this phase the player is asked to perform a skill that is required during the game — for example, a sidestep. If the player is able to perform to the satisfaction of the assessor, then the player can return to the game.

Assessment can be stopped at any stage if damage is apparent; for example, if the player feels pain. In the case of minor injuries, it is often possible to continue play. However, should there be a risk of further damage through continued play, it is advisable to remove the player from the game.

**FIGURE 11.19** The TOTAPS regime
11.2 Sports medicine and the demands of specific athletes

CRITICAL QUESTION
How does sports medicine address the demands of specific athletes?

11.2.1 Children and young athletes
Children and young athletes have special needs of which sports medicine practitioners need to be aware. Some of the more important issues concern treatment of specific medical conditions such as asthma, diabetes and epilepsy; management of overuse injuries, providing advice about thermoregulation and giving guidance in resistance training programs.

Medical conditions
Sports medicine personnel need to be aware of the correct management of the medical conditions asthma, diabetes and epilepsy.

Asthma
More than 2 million Australians (10 per cent of the population) suffer from asthma. While asthma may affect performance if not managed correctly, it should not be an excuse to avoid participation in sport, except in extreme cases.

In fact, many elite sportspeople, including several Olympic gold medallists, are asthmatic. Asthma usually begins with coughing and wheezing and can lead to considerable fatigue.

Activity can provoke an asthma attack. This is called exercise-induced asthma (EIA). During this condition, the airways are dilated during the physical activity but constrict immediately activity ceases, leading to an asthma attack (see figure 11.20).

Some activities provoke more asthma attacks than others. For example, there is a significant risk of an asthma attack occurring with running, some risk with cycling and little risk with swimming. The cause is related to the cooling process of nerve endings in the air passageways, which is more extreme during running-type activity. Swimming in warm water carries far less risk, as inspired air is saturated with warmer water vapour and the nerve endings are not cooled to the same degree.

It is generally agreed that exercise is of more benefit to asthmatics than no exercise at all. Swimming is the preferred form of exercise, as the warm, moist environment is less likely to cause an attack. During breathing, air is forced out of the lungs and into the water, which improves lung function.
FIGURE 11.20 During an asthma attack, the airways leading to the lungs become narrow.

The following measures help sufferers work with and possibly control their asthma.

- Activity should be preceded by controlled breathing and relaxation exercises.
- Use a gradual warm-up and conclude with a leisurely warm-down.
- Exercise intensity needs to be steady.
- If medication is required, it is essential to use it before exercise.
- Adequate water must be consumed.
- If attacks are triggered by environmental factors, remove the athlete from that environment.

If first aid is required, follow the directions outlined by the National Asthma Council in the chart ‘First Aid for Asthma’ (see figure 11.21).

**Diabetes**

**Diabetes** is a disease in which the body does not produce or properly use insulin. There are two types of diabetes. Type I diabetes is caused by the body’s inability to produce insulin, whereas the more common type II diabetes is caused by the body’s inability to produce sufficient insulin or use it efficiently. Insulin is produced in the pancreas and is important in the metabolism of carbohydrates. The condition leads to high blood glucose levels.

Until recently, children with diabetes were discouraged from participating in physical activity. However, today diabetics participate in all sports although caution needs to be exercised when considering some activities.

Exercise is of considerable assistance in managing diabetes. The diabetic athlete must balance insulin by way of injection, food intake and exercise if their physical performance is to be optimal. Their diet needs to be well balanced, with complex carbohydrates forming a significant portion. Because exercise increases the utilisation of sugar, diabetics require a pre-game meal to raise blood sugar levels and hourly glucose supplementation (for example, a banana) if exercise is protracted.
First Aid for Asthma

1. Sit the person comfortably upright. Be calm and reassuring. Don’t leave the person alone.

2. Give 4 puffs of a blue/grey reliever (e.g. Ventolin, Asmol or Albuterol) in a metered-dose inhaler (MDI) if available. If not, use first aid kit inhaler or borrow one. Give 2 separate doses of a Bricanyl or Symbicort inhaler if a puffer is not available; you can use a Symbicort (people over 12) or Bricanyl, even if the person does not normally use these.

3. Wait 4 minutes. If the person still cannot breathe normally, give 4 more puffs.

4. If the person still cannot breathe normally, CALL AN AMBULANCE IMMEDIATELY (DIAL 000) Say that someone is having an asthma attack. Keep giving reliever. Give 4 puffs every 4 minutes until the ambulance arrives.

   - WITH SPACER
     - Assemble spacer
     - Remove puffer cap and shake well
     - Insert puffer upright into spacer
     - Place mouthpiece between teeth and seal lips around it
     - Press once firmly on puffer to force medicine into spacer
     - Take 4 breaths in and out of spacer
     - Breathe out mouth
     - Repeat 1 puff at a time until 4 puffs taken — remember to shake the puffer before each puff
     - Replace cap
   
   - WITHOUT SPACER
     - Remove cap and shake well
     - Breathe out away from puffer
     - Place mouthpiece between teeth and seal lips around it
     - Press once firmly on puffer while breathing in slowly and deeply
     - Breathe out slowly away from puffer
     - Hold breath for 4 seconds or as long as comfortable
     - Repeat 1 puff at a time until 4 puffs taken — remember to shake the puffer before each puff
     - Replace cap

Bricanyl or Symbicort

   - Unscree cover and remove
   - Hold inhaler upright and twist grip around and then back
   - Breathe out slowly away from inhaler
   - Place mouthpiece between teeth and seal lips around it
   - Hold breath for 4 seconds or as long as comfortable
   - Slip inhaler out of mouth
   - Breathe in forcefully and deeply
   - Breathe out slowly away from inhaler
   - Repeat to take a second dose — remember to twist the grip both ways to reload before each dose
   - Replace cover

Not Sure if it’s Asthma?
CALL AMBULANCE IMMEDIATELY (DIAL 000)
If a person stays conscious and their main problem seems to be breathlessness, follow the asthma first aid steps. Asthma reliever medicine is unlikely to harm them even if they do not have asthma.

Severe Allergic Reactions
CALL AMBULANCE IMMEDIATELY (DIAL 000)
Follow the person’s Action Plan for Anaphylaxis if available. If the person has known severe allergies and seems to be having a severe allergic reaction, use their adrenaline autoinjector (e.g. EpiPen, Anapen) before giving asthma reliever medicine.

Although all care has been taken, this chart is a general guide only which is not intended to be a substitute for individual medical advice/treatment. The National Asthma Council Australia expressly disclaims all responsibility (including for negligence) for any loss, damage or personal injury resulting from reliance on the information contained. © National Asthma Council Australia 2011.

Epilepsy

Epilepsy is a disruption to brain function, causing a brief alteration to the level of consciousness and resulting in seizures or fits. It should not prohibit people from becoming involved in sport or activity. However, the circumstances of each individual should be assessed and they should be guided by their doctor. It is generally believed that, if seizures occur on a daily or weekly basis, collision sports should be avoided. If seizures are controlled through medication or occur only during sleep, epilepsy should not prevent participation in a wide range of sporting activities. Other players, parents or supervisors should be present and know what to do if a seizure occurs. Some activities, such as swimming alone, scuba diving and rock climbing, must be completely avoided, as a seizure may go unnoticed or cause loss of control, leading to serious injury or death.

Inquiry

Epilepsy and sport

Find information about epilepsy and sport to answer the following questions. The weblink [Epilepsy](#) may assist.

1. How may sport benefit people with epilepsy?
2. List six sports that need careful consideration for people who have difficulty with seizure control.
3. What advice should be given to people who experience epilepsy and choose to play sport?

Overuse injuries

Overuse injuries occur because of repeated use of a part of the body, causing tissue damage and considerable discomfort. The injuries are subtle, developing over a period of time and recurring following brief periods of rest. In effect, the injury has not had sufficient time to heal properly. Examples of overuse injuries that commonly affect children and young athletes are stress fractures, tennis elbow, Achilles tendonitis, swimmer’s shoulder and runner’s knee.

Children and young athletes are susceptible to overuse injury because of different growth rates in bone and soft tissue. The most common causes of overuse injury are:

- high training volume and intensity
- high training frequency
- inadequate warm-ups
- lack of a good general level of fitness
- biomechanical problems leading to stress on particular parts of the body
- unsuitable equipment such as running shoes that do not provide proper support
- poor technique or changes in technique leading to joint stress
- strength and flexibility imbalances leading to poor body alignment.

Overuse injuries are a risk in children and young athletes who train frequently during the week and play sports on both days of the weekend. To help avoid the risk of overuse injuries it is suggested that children have days of non-training and monitor the volume and intensity of their exercise activities.

One of the most common forms of overuse injury is the stress fracture.

Signs and symptoms of stress fractures include:

- gradual onset of pain, which tends to be localised
- pain increasing if it is not adequately treated
- local swelling and tenderness.
A common type of stress fracture that occurs in the lower leg is shin splints (see figure 11.22).

Adequate treatment of a stress fracture requires:
• immediate rest lasting from four to eight weeks, depending on the severity of the injury
• frequent use of ice to reduce inflammation
• possible use of anti-inflammatory medication
• maintaining physical condition by pursuing activities that do not involve the injured part in pounding movements — for example, swimming
• use of corrective devices and exercises to improve body mechanics if stress fractures were caused by biomechanical factors.

Thermoregulation
Temperature control through balancing heat loss with heat gain is managed through thermoregulation. Thermoregulation refers to maintenance of a stable internal temperature independent of the temperature of the environment. Children are at increased risk from environmental stress when compared to adults. Children do not have the same ability to lose heat through evaporation at the same rate as adults. This is because their sweat glands release fluid more slowly and are less responsive to temperature changes. Children therefore rely more on radiation and convection to lose heat.

Children’s acclimatisation to heat is also slower, putting them at greater risk on hot, humid days. They have shorter tolerance time in extreme heat, increasing the possibility of dehydration. Research also suggests that children have a higher chance of developing hypothermia from exposure to cold when compared to adults, placing them at greater risk in these environments.

Appropriateness of resistance training
Most literature supports the use of a safe program incorporating low resistance with high repetitions through the full range of motion. A strength training program for children must be an integral part of an overall program designed to improve skill and fitness. It should not be competitive. It is important that strength specialisation (for example, focusing on power or absolute strength) be avoided, as this can lead to imbalances between muscle groups and contribute to injury. Overall, there is considerable benefit from well-supervised programs and little risk of injury if guidelines are followed (see table 11.2).
TABLE 11.2  Basic guidelines for resistance exercise progression in children

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 or younger</td>
<td>Introduce child to basic exercises with little or no weight; develop the concept of a training session; teach exercise techniques; progress from body weight calisthenics, partner exercises, and lightly resisted exercises; keep volume low</td>
</tr>
<tr>
<td>8–10</td>
<td>Gradually increase the number of exercises; practise exercise technique in all lifts; start gradual progressive loading of exercises; keep exercises simple; gradually increase training volume; carefully monitor toleration to the exercise stress</td>
</tr>
<tr>
<td>11–13</td>
<td>Teach all basic exercise techniques; continue progressive loading of each exercise; emphasise exercise techniques; introduce more advanced exercises with little or no resistance</td>
</tr>
<tr>
<td>14–15</td>
<td>Progress to more advanced youth programs in resistance exercise; add sport-specific components; emphasise exercise techniques; increase volume</td>
</tr>
<tr>
<td>16 or older</td>
<td>Move child to entry-level adult programs after all background knowledge has been mastered and a basic level of training experience has been gained</td>
</tr>
</tbody>
</table>

Note: If a child of any age begins a program with no previous experience, start the child at previous levels and move him or her to more advanced levels as exercise toleration, skill, amount of training time and understanding permit.


Inquiry

Growth plate injuries

‘Of all youth sports, competitive baseball is one of the greatest concerns because of its potential for serious epiphyseal injuries resulting primarily from the pitching motion.’

1. Use your research skills to investigate the nature of the epiphyseal plate and its importance to bone maturation and development. How can fractures affect body growth?

2. Investigate specific sports movements that might contribute to epiphyseal plate damage and suggest how the sport can be modified to prevent this occurring.

Inquiry

Children and young athletes

Use an enlarged copy of the following chart to help analyse the implications of medical conditions, overuse injuries, thermoregulation and resistance training to young children and athletes playing sport.

<table>
<thead>
<tr>
<th>Issue for consideration</th>
<th>Implications</th>
<th>How it should be managed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overuse injuries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermoregulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On Resources

Weblink: Epilepsy
11.2.2 Adult and aged athletes

The most obvious concern for adult and aged athletes is pre-existing health risks. An older person who has a history of involvement in regular aerobic-type activity will probably not be at risk to the same degree as a person who suffers from obesity, hypertension, asthma or emphysema. However, heart conditions and bone and joint mobility problems have a significant effect on the options available to adults and older people.

Heart conditions

People with heart conditions include individuals who suffer from high blood pressure, have experienced a heart attack or other heart problems, or have had bypass surgery. For many years, exercise for these groups was considered dangerous and to be avoided. It is now known that prescribed exercise conveys considerable benefit with little risk to people in these groups. Exercise reduces blood pressure in moderately hypertensive patients by an average of 11 systolic and nine diastolic points. However, to gain the maximum benefit, exercise needs to be combined with a balanced diet with low fat and low salt intake.

People with existing heart conditions should obtain medical clearance before starting an exercise program. Some people may require a stress test to determine the level of intensity their circulatory system will tolerate. Supervision may be required in the early stages, particularly if the person has been sedentary in the past.

Aerobic exercise such as walking, cycling, jogging and swimming present the best options for people who have not been active for a period of time. It is important that they begin slowly and progress gradually, using an exercise program that suits the individual, such as 30 minutes per day, three times a week. The intensity of exercise (how hard you are working) should steadily increase, then level off. This ‘steady state’ heart rate is considered safe as long as it is 10 or more beats per minute lower than levels that trigger abnormal signs or symptoms (nausea, shortness of breath, dizziness, abnormal heart rhythm and chest pain). This level can be determined by stress tests. It is important that each session begins with a warm-up and that progression is smooth and graded.

The key principles for sports participation for people with heart conditions are:
• initially, they require medical clearance
• exercise must be aerobic
• progress must be gradual
• activity needs to be of moderate intensity
• the program should be tailored to individual tastes
• the program must be sustainable as benefits accrue only after a period of months.

People with heart conditions can also benefit from modified strength training programs. To be safe, light loads must be used and the program must include the major muscle groups. Heavy weights and pure isometrics are not recommended, as they can raise blood pressure to dangerous levels.
Fractures and bone density

Osteoporosis is a type of musculoskeletal condition in which there is deterioration in the bone structure. The bones become thin and weak, leading to an increased risk of bone fracture. The most important objective of sports participation programs for people who have osteoporosis is to reduce the risk of falls and subsequent fractures.

Physical activity increases bone mass and makes bones stronger. Exercise is particularly important to older women because it contributes significantly to delaying post-menopausal bone density loss. Inactivity should be avoided, as this encourages calcium discharge from bone, making it weaker. Sport and exercise programs need to be safe, beneficial and not cause pain. They should focus on improved physical fitness, particularly in the areas of balance, strength, coordination, aerobic capacity and flexibility. Gains in these areas lessen pain, increase confidence and broaden the range of activities available.

However, before beginning a new activity, the risk of a fall should be noted and the activity avoided if this risk is of concern. Types of exercise and sports options available include:
- endurance activities such as walking, cycling, swimming
- low impact and balance activities such as aerobics
- low range strengthening exercises focusing on the limbs, trunk and back.

High loads must be avoided and resistance developed gradually. The advice of a doctor or physician is encouraged in this area. The aim of these options is to develop postural retraining; that is, to teach safe ways of performing movements such as lifting and to avoid further fractures. People with osteoporosis need to be guided by their physician so that medication, exercise prescription and diet all work to improve safety and bone strength (see also sub-topic 11.2.3).

Flexibility and joint mobility

Exercise has a positive effect on flexibility and joint mobility in older people. Arthritis, aching joints and tight muscles, problems often experienced by older people, respond positively to exercise programs that focus on safe stretching and improving the range of motion in joints. Programs should also increase balance and stability and aim to reduce fractures caused by falls.
Programs need to:
• be low impact
• be specific to a person’s physical limitations
• consider existing medical conditions that might limit movement.
Generally, options available to this group include activities such as walking, cycling, swimming, flexibility classes and aqua-aerobics. Tai Chi has also gained in popularity because it is safe, controlled, low impact and promotes balance.

**Inquiry**
**Older people and exercise**
Use the Nutrition Australia weblink in your Resources tab. What are the benefits of exercise for older people? How can strength, aerobic fitness, core stability, balance and coordination be improved in older people?

**Inquiry**
**Exercise recommendations for older adults**
Find information about exercise guidelines for older adults.
1. Outline an exercise prescription for older adults that addresses mode, intensity, frequency, duration and progression.
2. How does physical activity need to be modified to suit the needs of older adults?
The Exercise recommendation for older adults weblink in the Resources may assist.

**Inquiry**
**Medical conditions and sports participation options**
Research sports participation options available for aged people with medical conditions.
1. What types of activity are recommended?
2. Why are they considered safe?
The Medical conditions weblinks in the Resources tab may assist in finding information.

**Resources**
- Weblink: Nutrition Australia
- Weblink: Exercise recommendation for older adults
- Weblink: Medical conditions

**studyon**
- Option 3 Question 2 Topic 2 Concept 1 Heart conditions Summary screen and practice question

**studyon**
- Option 3 Question 2 Topic 2 Concept 2 Fractures and bone density Summary screen and practice question
11.2.3 Female athletes

Female athletes have special dietary needs, including increased iron and calcium requirements. Iron levels are depleted by physical training and menstruation. Calcium is important in promoting strong bone growth and a sturdy structure for muscle attachments. Eating a wide variety of foods is recommended as no single food contains all the vitamins and minerals required for adequate functioning of essential body processes. Lack of energy and possible harm to the body can be caused by an unbalanced diet.

Eating disorders

Eating disorders are characterised by behaviour such as purging, binge eating and starving. The most common eating disorders are anorexia nervosa and bulimia nervosa. It has been found that eating disorders affect more than half of the athletes who compete in events where low body fat and an idealised body shape and size are expected. Examples of activities where sport-specific physiques are an advantage include gymnastics, synchronised swimming, diving and dance. Running and swimming are also affected, but to a lesser degree.

Female athletes have twice the risk of developing eating disorders, which may result from:

- exposure to peer influence, magazines, television and other forms of media that make athletes susceptible to the pressures of weight loss
- exposure to social expectations to be thin within the athletic subculture; for example, the desire for an ‘athletic shape’
- the need to conform to an ideal sporting image that overvalues ideal body shape, size, weight and low body fat.

Female athletes such as gymnasts and divers find themselves pressured to conform to an ideal body size and weight. In these sports, body shape is not mentioned as part of the marking criteria although the body is clearly revealed. Thinness is an advantage to artistic and technical merit, which is considered when arriving at a score. Athletes in these sports can find themselves under significant pressure and even incur serious emotional damage in trying to please coaches and judges. In the 1980s and early 1990s, the importance of having the ideal shape for a particular sport escalated, making the problem of eating disorders of increasing concern. For example, in 1976 the average height of female gymnasts was 1.6 metres and average weight was 47.7 kilograms. In 1992, the average height had dropped to 1.4 metres and average body weight to 40.0 kilograms. Concern for the welfare of very young female gymnasts led, in 1996, to an increase in the age at which girls can compete in international gymnastics competitions to 16 years.

To help prevent eating disorders from developing in athletes, it is important that trainers and coaches:

- expect athletes do their best and not focus solely on winning
- be better educated to detect signs of eating disorders and use nutrition experts and counsellors to program and advise in these areas
• observe training routines and social practices such as eating and take action when suspicious
behaviours are disguised or turn into an obsession
• invite parents to training sessions to observe coaches to ensure that excessive pressure is not placed on
athletes to meet unreasonable dietary or body size demands.

Iron deficiency
Although iron is required in only small amounts, many women consume less than the recommended amount.
Iron deficiency causes anaemia. Anaemia is a condition in which there is an abnormally low level of
haemoglobin, resulting in less oxygen being available to tissues.

If haemoglobin levels drop below 11 grams per 100 mL of blood, the person is considered to be anaemic.
Haemoglobin forms the bulk of red blood cells. It binds with oxygen in the lungs and transports it to the
muscle tissues. While only small amounts of iron are required in the body, the mineral plays a critical role in
oxygen transportation. Without sufficient iron, the number of red blood cells is reduced, limiting the oxygen-
carrying capacity of the blood and the degree to which the athlete is able to participate in sport. Iron deficiency
contributes to fatigue and loss of energy. The problem is more evident in females because they usually consume
less red meat and can lose from five to 40 mg of iron during menstruation. The recommended daily intake for
females is very small (15 mg), but many women do not consume this level of iron.

Exercise-induced anaemia (sports anaemia) is common in female athletes and is believed to be the result of
intense training where iron reserves are heavily drained. Some believe this is caused by loss of iron in sweat
together with the destruction of red blood cells from body temperature increases. The pounding effect of feet
on hard surfaces may be an additional factor. This does not mean that every female athlete needs to take iron
supplements. However, it does suggest that iron levels need to be monitored constantly and increased only
as required. Supplementation benefits people whose intake is below recommended levels, but is of no benefit
to those whose intake is satisfactory. Indiscriminate use of iron tablets can cause iron levels to reach toxic
amounts and contribute to liver disease, diabetes, heart problems and joint damage.

Bone density
Bone density is directly related to the quantity of calcium in the bones. Bones that lack calcium are susceptible
to fractures and structural weakening. This may happen in the spinal cord for example, which contributes to a
hunchback. Calcium is regulated by the parathyroid glands, which control how much calcium is stored in the
bones and how much will be released to the body. If the parathyroid glands become overactive, calcium from
bone tissue is released to the bloodstream, causing bones to become brittle and contributing to a condition called osteoporosis. Bone is strongest when a person is in their twenties, with deterioration beginning in the mid-thirties. Following menopause, women lose calcium faster than men and some may require a form of oestrogen therapy.

Female athletes need to be aware of how bones will be affected by age, particularly post-menopause. Women beginning sports programs should focus on safety in activity and choose aerobic sports such as swimming, cycling, running and aerobics. Female athletes in continuing programs need to be aware of the effect of age and menopause on bone density. A well-balanced diet with adequate calcium-enriched foods, such as milk and cheese, is recommended. For women with osteoporosis it is important that activity includes a warm-up, progresses to stretching and that ice is used on inflamed or arthritic joints to prevent swelling and soreness.

**Pregnancy**

For some time it was thought that exercise caused excessive stress to the mother and the foetus. Most research now shows that sustained, moderate exercise creates no more stress to previously active, healthy women than the stress of weight gain. Furthermore, exercise regularly performed improves cardiovascular fitness. Moderation is the key, particularly if there is restricted placental blood flow that could place the foetus at risk. Pregnant women should exercise in the cool of the day and consume adequate water to avoid thermal stress, which can affect foetal development. It is easier to control these factors in self-regulated exercise programs than in competitive sports, which may have regulations regarding participation by pregnant women.

In an uncomplicated pregnancy, regular moderate exercise can have considerable benefits, including:

- maintenance of fitness and general well-being
- weight control in later stages of pregnancy
- improved muscle tone.

**Inquiry**

**Challenges faced by female athletes**

Choose one of the following conditions that may be experienced by female athletes: eating disorders, iron deficiency, decreasing bone density, or pregnancy. Critically analyse how the condition affects sports performance and what can be done to better manage the condition. Discuss your findings with the class.
Inquiry
Sports participation options available to aged people with medical conditions

In the table following is a list of medical conditions that affect aged people. Complete the table by listing five sport participation options and justifying your selection.

Be aware that the activities you choose need to be:

• low impact
• address a specific medical condition, for example, a heart condition, and
• tailored to meet any physical limitations, such as leg weakness following removal of a cast.

The following are examples of why activities are appropriate. Brainstorm with the class to add to your list.

• Improves bone density
• Improves aerobic capacity
• Improves specific health-related components of physical fitness (identify which)
• Aids posture
• Improves balance and stability
• Provides gradual strength improvement
• Aims to reduce the risk of fractures caused by falls
• Improves flexibility

<table>
<thead>
<tr>
<th>Medical condition</th>
<th>Sports participation options</th>
<th>Why is this type of activity appropriate?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart conditions</td>
<td>• Walking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Swimming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Modified strength training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Aerobic sports for seniors</td>
<td></td>
</tr>
<tr>
<td>Fractures/bone density</td>
<td>• Low impact aerobics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Swimming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tai-chi</td>
<td></td>
</tr>
<tr>
<td>Flexibility/joint mobility</td>
<td>• Safe stretching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Modified strength training</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Yoga</td>
<td></td>
</tr>
</tbody>
</table>

Inquiry
Addressing the demands of specific athletes

Draw a web or bubble map to summarise responses to the following critical question: ‘How does sports medicine address the demands of specific athletes?’
11.3 Preventative action — Enhancing the well-being of the athlete

CRITICAL QUESTION
What role do preventative actions play in enhancing the well-being of the athlete?

The well-being of an athlete can be enhanced by developing skills that contribute to personal safety and taking preventative action in training and competition environments. While most injuries do not require surgery, some injuries do require hospitalisation and can keep the athlete from training and playing for some time. However, many of these injuries are preventable through preparation.

SNAPSHOT
Which sports send the most Australians to hospital?
Did you know sports injuries cause around 36 000 Australians a year to have a hospital stay? But whether it's football, wheeled motor sports or cycling that's most dangerous depends on how you look at it.

When it comes to injuries sustained from sport that are bad enough to have you hospitalised, which sports are the riskiest?
It depends on how you look at it, a new report from the Australian Institute of Health and Welfare (AIHW) suggests.

The various forms of football are responsible for the largest proportion of the total number of sports-related injuries in Australia requiring hospitalisation — nearly a third.

And of the football codes, Australian Rules and soccer had the highest population-based rates of injury hospitalisation, with 18 and 17 cases per 100 000 population respectively.

So is this justification for those who worry when the men in their life — and it is mostly males — play football? Perhaps not.

The finding is more a reflection of the large numbers of people who play football, rather than it being inherently the most dangerous.

When the number of participants is factored in, wheeled motor sports, such as motorcycling and go-carting, appear riskier with more than 3500 hospitalisations per 100 000 participants.

This was followed by roller sports, such as roller skating and skateboarding, with more than 2000 hospitalisations per 100 000 participants.

Roller sports had almost double the injury rate of Australian Rules and rugby, which had 1319 and 1292 hospitalisations per 100 000 participants respectively.
The ups and downs of sport

But injury researcher and AIHW spokesman Professor James Harrison says the findings need to be kept in perspective and aren’t in themselves a reason to stop playing any of the sports.

‘There are very good reasons to engage in sport. Sport’s fun and a really good way to get fit and stay fit,’ says Harrison, director of the Research Centre for Injury Studies at Flinders University. He also points out that the apparent riskiness of wheeled motor sports might be exaggerated somewhat because of problems with the way the data used in the analysis was collected.

‘Motor sports come out very high. I suspect part of that’s just to do with the roughness of the information [collected] in hospitals.’

When it comes to the severity of injuries you might sustain, three sports stand out. Cycling, motor sports and equestrian activities had a particularly high proportion of more severe injuries, with about one quarter of cases considered to be life-threatening.

But wheeled motor sports was the activity that accounted for the highest total number of days spent by patients in hospital — over 9500 days.

The report showed that those suffering sporting injuries were overwhelmingly under 35 and mostly men.

The most commonly affected body region was the knee and lower leg and the most common diagnosis was a fracture.

<table>
<thead>
<tr>
<th>Type of sport</th>
<th>Number of cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Rules football</td>
<td>3186</td>
<td>8.8</td>
</tr>
<tr>
<td>Soccer</td>
<td>2962</td>
<td>8.2</td>
</tr>
<tr>
<td>Cycling</td>
<td>2917</td>
<td>8.0</td>
</tr>
<tr>
<td>Football, other and unspecified</td>
<td>2821</td>
<td>7.8</td>
</tr>
<tr>
<td>Wheeled motor sports</td>
<td>2737</td>
<td>7.6</td>
</tr>
<tr>
<td>Water sports (individual and team)</td>
<td>2143</td>
<td>5.9</td>
</tr>
<tr>
<td>Rugby, unspecified</td>
<td>1650</td>
<td>4.6</td>
</tr>
<tr>
<td>Roller sports</td>
<td>1632</td>
<td>4.5</td>
</tr>
<tr>
<td>Equestrian activities</td>
<td>1568</td>
<td>4.3</td>
</tr>
<tr>
<td>Basketball</td>
<td>1322</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Inquiry

Which sports send the most Australians to hospital?

Read the snapshot ‘Which sports send the most Australians to hospital?, then answer the following questions.

1. Why is Australian Rules football the major contributor to sports injuries resulting in hospital treatment?
2. Examine the list of sports that contribute most to sport injury statistics. Identify 10 strategies that would assist in preventing injury in these sports.
11.3.1 Physical preparation

Physical preparation enables the body to better cope with the demands of the sport or activity. The athlete undertakes training sessions that stress physiological capacities, making them adapt to the pressures required in the competitive environment. This may involve activities such as resistance training, interval training and general conditioning.

Pre-screening

Before beginning a training program, it is essential that subjects at risk be pre-screened. Pre-screening assesses the health status of a person before they become involved in a training program. Age, gender, health status and previous experience are important criteria in the screening process. For example, a person who wishes to begin a program at the age of 40 years and who has a history of active involvement in fun runs and other aerobic activities such as soccer will not have the same elements of risk as an older, obese, unfit person. Pre-screening is especially important for:

- males more than 40 years of age
- females more than 50 years of age
- asthmatics
- people who smoke, are obese or who have high blood pressure
- people with a family history of heart conditions.

An example of a pre-exercise screening questionnaire is given in figure 11.30. This example is promoted by Sports Medicine Australia as a tool for:

- identifying people who are at high risk of acute cardiovascular problems (see stage 1). These people must first obtain medical clearance before commencing aerobic exercise or training.
- identifying people at low or moderate risk (see stage 2).

A tailored exercise program, sometimes under medical supervision, can then be devised to suit their needs.

Pre-screening is also a tool for encouraging people to begin and maintain an exercise program using an exercise prescription. An exercise prescription specifies what we need to do to achieve a desired level of fitness. By understanding their limitations and with guidance on appropriate levels of exercise, people can avoid muscle soreness and losing motivation, which can occur if they do too much too soon.

An exercise prescription specifies:

1. how often we should work (frequency)
2. how hard we should work (intensity)
3. for how long we should work (time/duration)
4. the kind of work we can do (type).

Application

Assessing risk factors

1. Complete the questionnaire in figure 11.30, stage 1.
2. From the information in figure 11.30, stage 1, establish if you would need medical clearance before you started an exercise program.
FIGURE 11.30 Pre-exercise screening

Stage 1 Questionnaire

<table>
<thead>
<tr>
<th>Name:</th>
<th>Age:</th>
<th>Gender: M F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td>Phone:</td>
<td>Date:</td>
</tr>
</tbody>
</table>

1. Have you ever had a heart attack, coronary revascularisation surgery or a stroke? No Yes
2. Has your doctor ever told you that you have heart trouble or vascular disease? No Yes
3. Has your doctor ever told you that you have a heart murmur? No Yes
4. Do you ever suffer from pains in your chest, especially with exercise? No Yes
5. Do you ever get pains in your calves, buttocks or at the back of your legs during exercise which are not due to soreness or stiffness? No Yes
6. Do you ever feel faint or have spells of severe dizziness, particularly with exercise? No Yes
7. Do you experience swelling or accumulation of fluid about the ankles? No Yes
8. Do you ever get the feeling that your heart is suddenly beating faster, racing or skipping beats, either at rest or during exercise? No Yes
9. Do you have chronic obstructive pulmonary disease, interstitial lung disease, or cystic fibrosis? No Yes
10. Have you ever had an attack of shortness of breath that developed when you were not doing anything strenuous, at any time in the last 12 months? No Yes
11. Have you ever had an attack of shortness of breath that developed after you stopped exercising, at any time in the last 12 months? No Yes
12. Have you ever been woken at night by an attack of shortness of breath, at any time in the last 12 months? No Yes
13. Do you have diabetes (IDDM or NIDDM)? If so, do you have trouble controlling your diabetes? No Yes
14. Do you have any ulcerated wounds or cuts on your feet that do not seem to heal? No Yes
15. Do you have any liver, kidney or thyroid disorders? No Yes
16. Do you experience unusual fatigue or shortness of breath with usual activities? No Yes
17. Is there any other physical reason or medical condition, or are you taking any medication(s) which could prevent you from undertaking an exercise program, or that you are concerned about? No Yes

Stage 2 Age and Risk Factors

Stage 2A:
- Is the client in the ‘older’ age category (45 years and over if male; 55 years and over if female)?
If ‘yes’, the client is in a moderate risk group due to their age; the client does not need medical clearance before beginning a low–moderate intensity exercise program; the client can undertake low–moderate intensity submaximal aerobic fitness testing.

Stage 2B:
- Does the client smoke cigarettes regularly or have they quit smoking in the last 6 months?
- Does the client have a first male relative (father, brother, son) or female relative (mother, sister, daughter) who has had a myocardial infarction, coronary revascularisation, or died suddenly due to a heart attack before the age of 55 years (males) or 65 years (females)?
- Does the client have impaired fasting glucose (equal to or greater than 6.1 mmol.L\(^{-1}\) on two separate occasions)?
- Does the client have systolic blood pressure measured greater than or equal to 140 mmHg on two separate occasions, or diastolic blood pressure measured at greater than or equal to 90 mmHg on two separate occasions, or are they on antihypertensive drugs?
- Does the client have a total serum cholesterol concentration of greater than 5.2 mmol.L\(^{-1}\) or HDL less than 0.9 mmol.L\(^{-1}\) or is the client on lipid-lowering medication?
- Does the client have an occupation where they are seated for long periods and they do no regular exercise, or does the client not meet current PA guidelines of 150 min of moderate PA per week?
- Is the client obese (BMI greater than or equal to 30) or do they have a waist girth greater than 100 cm?
If the client has two or more risk factors as identified from the questions in Stage 2B, the client is in a moderate risk group; the client does not need medical clearance before beginning a low–moderate intensity exercise program; the client can undertake low–moderate intensity submaximal aerobic fitness testing; the client does need medical clearance before beginning a vigorous exercise program or undertaking aerobic fitness testing to vigorous intensity levels.

Inquiry
Using the information in the pre-exercise questionnaire
Many of the conditions mentioned in figure 11.30, stage 2, may not be relevant to you at this point in your life. Suggest those that may be of concern in 20 years time (for example, blood pressure). What could you do to prevent these conditions developing?

Skill and technique
Skill and technique relate to the efficiency with which we perform the required activities. Skilful players perform difficult movements with ease and precision. They display a high degree of temporal patterning (the smaller parts of the movement are executed in sequence), pacing (movements are precisely timed) and control. These features are acquired and developed through effort and practice.

Correct skill development is essential to prevent injury. The footballer who is unsure of correct tackling technique is at risk each time they make a tackle. The basketballer who is unable to rebound competently places his or her knees at risk of injury with each landing. Wrestlers who have inferior falling techniques risk injury each time they are thrown on the canvas. Most people appreciate the importance of skill acquisition to improved performance. It is equally important in the prevention of serious injury.

Physical fitness
A most important preventative action in enhancing the well-being of athletes is to ensure that the level of physical fitness required by the sport is attained before full competition begins. Physical fitness has a range of attributes and the quantity required of each depends on the type of sport or activity. Some sports such as rugby require superior cardiorespiratory fitness together with high levels of strength, power, speed, endurance and agility depending on the position played. Other sports such as gymnastics require less cardiorespiratory fitness but more flexibility, coordination and balance while being aware of body composition.

Lack of development of the appropriate level of fitness for a particular sport is a major contributing factor to injury. A level of physical fitness fitting to the sport ensures that energy supplies are adequate and body systems are able to meet the demands of what is required in the activity.
Warm-up, stretching and cool-down

Adequate warm-up, stretching and cool-down are important in enhancing performance and preventing injury.

Warm-up

Warm-up and cool-down are probably the most important injury prevention features of any training program. It is uncommon to see teams take the field without warming up. However, it is common to see inappropriate warm-ups. Cool-downs are often neglected.

As with all training programs, the warm-up needs to be geared to the demands of the sport. The time taken for warm-up varies depending on the activity. While it is not uncommon for sprinters to warm up for 45 minutes prior to a 10- to 12-second event, 20 to 25 minutes is often enough for sports such as touch football and netball. As a general rule, sports that require explosive movements such as sprinting, discus throwing and gymnastics require a longer warm-up than other activities where the prime demand is endurance (for example, cycling).

Warm-ups cause redistribution in blood flow. When we are not exercising, most of our blood is located in the internal organs where it aids digestion and circulation. However, activity causes blood to be drawn to the skeletal muscles where oxygen and nutrients are needed by the cells to enable muscle contraction. Higher muscle temperatures increase the ability of the muscle to stretch without tearing and improve the time that it takes a muscle to respond to a stimulus (reflexes). This is associated with positive psychological feelings — the knowledge that the muscle will respond at the time because it has already done so. The same responsiveness does not occur in muscles that have not been warmed up.

The phases of the warm-up, suggested activities and benefits are listed in table 11.3.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Nature</th>
<th>Suggested activities</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General body warm-up</td>
<td>Jogging and skipping</td>
<td>• increased blood flow</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• raised muscle temperature</td>
</tr>
<tr>
<td>2</td>
<td>Stretching</td>
<td>Static stretches followed by PNF</td>
<td>• increased elasticity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>stretches</td>
<td>• increased muscle extensibility</td>
</tr>
<tr>
<td>3</td>
<td>Callisthenics</td>
<td>Push-ups, abdominal crunches, half</td>
<td>• strengthens muscle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>squats, star jumps</td>
<td>• draws blood from internal organs to skeletal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>muscle</td>
</tr>
<tr>
<td>4</td>
<td>Skill rehearsal</td>
<td>Drills and routines</td>
<td>• increased agility</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• game readiness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• maintenance of body temperature</td>
</tr>
</tbody>
</table>

Stretching

Muscles lose elasticity with age, so everyone should participate in a general stretching program at least four or five times per week. However, sportspeople are unique and require additional, specific flexibility according to the demands of their particular sport. Muscles need to be stretched beyond the range required of them in the sport prior to the performance. This is achieved by a safe stretching program using the following types of stretch.

- Static stretches — a muscle or group of muscles is gradually stretched beyond their normal range and the stretch held for about 30 seconds (see figure 11.32).
- Proprioceptive neuromuscular stretching (PNF) — often performed with a partner, although this is not essential. A static stretch is followed by an isometric contraction and a relaxation phase in the lengthened position (see figure 11.33). The procedure continues until the desired amount of stretch is complete.
Stretching programs must be specific to the needs of the sport. The muscle groups that have greatest demands placed on them during the performance require specific attention. For example, a high jumper will stretch all major muscle groups in preparation for competition, but will give additional and specific attention to the calf and thigh muscle groups as the demands on these is greatest.

**Cool-down**

The cool-down (recovery) is the period following competition or physical activity where body temperature, circulation and respiratory rates return to their pre-exercise state (or as close to this state as possible). The cool-down is essential to:

- *maintain the stretch in muscle groups* that may have shortened during the activity. For example, the leg muscles of a cyclist may shorten if the legs do not reach full extension during pedalling.
- *disperse lactic acid* that has built up during exercise. Exercise recovery as opposed to rest recovery results in a more effective dispersal of lactate.
- *prevent blood pooling*. A gradual reduction in heart rate reduces vasodilation (supply of blood to the working muscles) and the tendency of blood to ‘pool’ in muscles that have been heavily worked.

An adequate cool-down involves stretching for approximately 10 minutes, performing callisthenics, and finishing with a gross motor activity such as a light jog or swim. This is the reverse of the warm-up. However, it is not as intense and need not go for the same period of time. To be effective, the cool-down must emphasise stretching (see figure 11.34), but need not include an extensive range of activities specifically related to the game skills.
Inquiry
Preventative strategies
Choose three different sports. For each sport, investigate strategies used to enhance physical preparation aimed at injury prevention.

study on

Option 3 Question 3 Topic 1 Concept 3 Physical fitness Summary screen and practice question

study on

Option 3 Question 3 Topic 1 Concept 4 Warm-up, stretching and cool-down Summary screen and practice question

11.3.2 Sports policy and the sports environment
Sports policy, rules of the game and equipment may need to be the subject of discussion and careful review if it is to improve the safety and well-being of athletes.

Rules of sports and activities
The rules of a sport assist the flow of play and protect participants from injury. Rules are enforced on the field by the referee or umpire and promote safety within the game. Injury has the potential to cause temporary and even permanent disability, so rule infringements must be dealt with. In collision sports, such as rugby league and rugby union, there is considerable potential for injury. This potential is significantly increased in the execution of common but illegal movements, such as the head-high tackle. As a result, both codes have well-defined rules stating what constitutes dangerous activity and a range of penalties to punish the offence.

Similar situations exist in other sports and activities. Marathon runners are obliged to consume fluid during their event to prevent heatstroke. Hockey goalkeepers must wear protective gear before being allowed to take the field of play. Softball catchers must wear face masks when they are in the catcher's position behind the batter. There are many other examples of rules that have been established to protect players from injury. It is essential that athlete safety is of the highest priority. Apart from the personal distress to the individual, many clubs have invested a lot of money in their players and do not wish to see them sidelined due to injury that could have been avoided. In rugby league, for example, it is not uncommon for the National Rugby League Judiciary to take legal action against players who cause injury to other players through violence or disregard for the rules.

FIGURE 11.35 Compliance with rules in sporting competitions helps enhance the safety of athletes.
Modified rules for children

Major modifications have been made to junior sport at most levels to accommodate the specific needs of children. Examples of changes include:

- lowering the backboard and ring in basketball and the ring in netball to enhance the chance of successful shooting
- using T-ball stands in softball to make contact with the ball easier
- modifying equipment and distances in Little Athletics to promote success
- simplifying the rules in most sport, so children require only a basic understanding to participate
- awarding trophies and certificates for achievements other than winning — for example, participation and effort.

Changes such as these are essential to encourage children to take part and continue in the activity. Children should not be seen as little adults, capable of using adult equipment on courts and fields marked for adults. Children, because of their stature and limited capabilities, have very specific needs in terms of equipment size, court dimensions, rules and playing environment. When this is suited to their needs, it adds to their potential to learn skills and enjoy sport as a willing participant. If children see themselves as failures in a particular activity, they will not continue. Both the rules and the environment need to promote enjoyment, involvement, continuity in the sport and safety.

Inquiry
My experience with modified sports
Discuss the extent to which your school and sports club (if applicable) modified equipment, grounds or facilities to cater for your needs when you were younger.

Matching of opponents

To promote safety, it is desirable to match children with others of comparable size. While the risk is higher in contact sports such as rugby, size variations do make a difference in sports such as hockey and cricket, where larger children may be able to hit harder or bowl faster. The problem is difficult to address because most schools and junior sport controlling bodies match teams on age. This is convenient because birth certificates are readily available. However, there can be vast differences in physical maturity between individuals of the same age.

Inquiry
Class debate
Debate the merit of selecting junior teams that play contact sports, such as rugby, rugby league or Australian Rules, based on their physical size or weight rather than their age.

Competitions that are even are desirable at all levels of junior sport. Consideration should be given to the size, age, gender, strength, psychological development and skill level of competitors. When competitions are even, skills are matched and interest is heightened. However, if competitions are uneven, non-competitive sides quickly lose interest. In junior sport, it is relatively straightforward to establish an even competition if winning is not the major goal and all players receive the same award at the end of the game. This promotes much more desirable behaviour, as players are able to match their skills against opponents of similar ability and enjoy competition for its own sake, not solely to win.
Use of protective equipment

Protective equipment is essential for players in most team sports. Ground surrounds and equipment must also be safe. Many sports make provision for the use of protective equipment. All protective equipment must:

• adequately protect the wearer and other players
• allow freedom of movement
• allow air flow as required
• be comfortable.

Examples of protective equipment commonly used in games include:

• mouthguards, which are used in sports such as basketball and football
• helmets, such as those used in cricket and cycling
• face masks, such as those used in baseball and softball
• padding (shin, shoulder, chest, thigh) as used in cricket, football and hockey
• wetsuits for surfing
• sunglasses, such as those commonly used in cricket, cycling, triathlons and golf
• hats to protect the face, ears and neck from potentially damaging ultraviolet rays
• gloves for hand protection in cricket and softball.

Good quality equipment is important for athlete safety. Equipment that costs more usually has been rigorously tested. The higher the risk of injury from impact in a sport or activity, the more important the need for equipment that is safe and reliable. In cricket, for example, where the ball can be bowled at considerable speed, the helmet is designed to protect the batsman from injury by a high-rising ball (see figure 11.37). The design of the helmet is crucial to the safety of the batsman. A gap that is too big and allows entry of the ball between the mask and metal grid, or a mask frame that breaks or bends on impact would leave the player at considerable risk. In sports and activities where the danger is highest and the risk of injury from equipment failure potentially serious, it is essential to use equipment that is rigid, supportive and reliable.

Footwear is both supportive and protective. Inappropriate footwear can lead to blisters, calluses and even structural deformities. Sports shoes are, and should be, unique to each individual sport. This is because different sports place different stresses on the foot. Football entails a lot of sidestepping on a grass surface, so there is a need for support (in the form of sprigs) to assist changes of direction. Basketball places different demands on footwear, requiring shoes that can grip a polished floor while the player performs agility skills and provide cushioned support when the player lands after a rebound.

The most popular sports shoe is that used for cross-training (a general purpose training shoe; see figure 11.38). Comfort is enhanced and injury is most likely to be prevented if the shoe:

• is comfortable but not too tight
• is firm when socks are worn, but does not cramp the toes
• is flexible where the toes bend
• has a high heel to support the Achilles tendon
• has a midsole that is soft but sturdy and is capable of absorbing impact
• has a supportive heel counter that is firmly attached to the sole
• has built-in support for the arch of the foot
• has a quality, non-slip sole.

FIGURE 11.38 The quality sports shoe has many features that promote safety and ensure comfort.

Safe grounds, equipment and facilities

Player safety is of paramount concern on all sporting occasions. It is the responsibility of the organising group to ensure that every effort has been made to match facilities to safety expectations. *Safety Guidelines for Children in Sport and Recreation*, by Sports Medicine Australia, recommends that an appropriate club or association official follow these guidelines when preparing for play.

• Ensure the playing surface is in reasonable condition, without holes, exposed sprinkler heads or hard patches.
• Clear away all rubbish, especially broken glass, stones and lids from bottles and cans.
• Check that corner posts and other field posts cannot injure players on contact (these should be made of cardboard or similar material).
• Ensure permanent fixtures such as goal posts are padded.
• Ensure perimeter fences are well back from the playing area.
• Ensure spectators, unnecessary equipment and vehicles are kept well back from the sidelines.
• Ensure lighting is adequate if playing at night.
• Ensure adequate matting where necessary — for example, in gymnastics.

Equipment must be checked each time before being used. According to *Safety Guidelines for Children in Sport and Recreation*, all equipment must be:

• suited to the size and ability of the child
• regularly checked and maintained
• sufficient in number
• padded appropriately
• stable or movable if necessary
• properly erected/constructed.

The design of fields, courts and general playing facilities must contribute to player safety. For example, if goals are in or close to the field of play, they must be padded. Players who go beyond the field of play through movements such as tackles must have enough room to be able to stop safely. Sponsor signs, timing devices, false start equipment and lane markers should not interfere with player movements on or off the field.

**Inquiry**

**School safety**

Independently, conduct a safety review of your school’s sporting competitions and facilities. Suggest areas, including procedures, equipment and facilities, that need to improve. Discuss your findings with the class and draft recommendations for improvement. Investigate reasons why some individuals choose not to wear available protective equipment.

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**SNAPSHOT**

**How the rugby league concussion test works**

You are playing a game of rugby league and you receive a significant head knock with a possible concussion — here is what officials will do for you from the moment you go down.

Concussion in contact sport is treated extremely seriously these days, and part of the treatment involves various tests that happen immediately after a head knock.

In the NRL, clubs are given a free interchange if a player leaves the field for a HIA (Head Injury Assessment).

But how does the HIA work? We will explain it step-by-step.

**You are first met by a trainer**

In the NRL, clubs have professional sports trainers who are trained to spot the signs of concussion. They will run out onto the field to assess an injured player, looking for any symptoms of concussion, such as loss of consciousness, dizziness, unsteadiness on the feet or memory loss when they talk to the player.

If they spot any of the symptoms, the player must be removed immediately from the field.

In junior divisions, such as the Illawarra Junior Rugby League divisions in New South Wales, the first person on the scene will be a qualified trainer like Pamela Goodridge.
“I’m watching for body language, like if they get to their feet a bit wobbly,’ she said.
I’ll sit them down [on the field] and ask them questions like what happened, and if they lost consciousness we call an ambulance straight away so they can see a doctor as soon as possible.
If they come off suffering from dizziness or headache, we watch them on the sideline and hopefully a parent or guardian is there who we can hand them over to.
If someone is not there, we ring someone to pick them up or they go with the coach who drops them home.’
Any junior rugby league player who suffers a suspected concussion leaves the ground with documents providing information about the injury, and is also required to see a doctor who will assess the player and clear them before they can return to training or a game.

You are concussed in the NRL and you are leaving the field
At the professional level, you will be escorted off the field by a trainer, who then hands you over to your team doctor and briefs them with their on-field findings.
You will then be helped to the dressing room while the doctor reviews television footage of your head knock in a purpose-built tent.
After watching the footage, the doctor will see you in the dressing room to conduct a neck examination and a test known as the SCAT3 — the Sports Concussion Assessment Tool.

What you will hear during your test
‘SCAT is a multimodal assessment tool to test different parts of the brain,’ NRL chief medical officer Paul Bloomfield said.
‘It includes a symptoms assessment and there are 23 symptoms the player self-rates.’
The test includes orientation questions, as well as the following:
• What venue are we at today?
• Which half is it now?
• Who scored last in this match?
• What team did you play last?
• Did your team win the last game?
Players are also tested on short-term and long-term memory and concentration techniques.
An example of this might be asking a player to repeat the numbers 4-5-1 in reverse order, up to a maximum of six digits.
Players will also undergo balance testing.
‘All these are assessed and compared to baseline scores from a test done pre-season,’ Dr Bloomfield said.
‘They can do that via a head injury assessment app which gives them an instant comparison to what their baseline is.’

When will you be told you cannot return to the field?
Dr Bloomfield said the head injury assessment process was not a pass or fail system, despite the common expression that someone has ‘failed the concussion test’.
‘You could “pass” the test but still have concussion because it’s a difficult and complex thing to diagnose,’ he said.
‘The doctor knowing the player well is an important part of that so they can pick up personality changes that may not be evident to someone who doesn’t know the player.'
‘We’ve had numerous cases where a player has passed the test but the doctor has kept them off because the player hasn’t seemed to be right to them.’

He said concussion symptoms changed rapidly over the minutes, hours and days following the injury.

‘There’s a small percentage of concussions that present even a day or so later which is why we have rules in place that even if they’ve been cleared to return to the field, they have to be assessed within 48 hours to make sure they don’t have any delayed symptoms.’

The importance of treating concussion
Once upon a time, if a player returned to the field after a concussion, it was seen as an act of bravery.

Today, the NRL has publicly stated it is an ‘act of stupidity’.

‘As we know more about concussion, the attitudes are changing at all levels to treat it appropriately and seriously,’ Dr Bloomfield said.

He said more serious issues like bleeding in the brain or skull fractures can present with concussion-like symptoms.

At a junior level, trainer Pamela Goodridge said the messages from the NRL have filtered down to junior football.

‘As of last year [2016], every game has to have a level one NRL sports trainer on site, and as the grades get higher, every team has to have a sports trainer at every game,’ she said.

Even at the junior representative level, the home team must provide a doctor who can treat both sides, while a team doctor is present for every NRL team at every game.

Inquiry
How the rugby league concussion test works
Read the snapshot ‘How the rugby league concussion test works’, then answer the following questions.
1. Investigate why concussion is so serious that it requires a special safety policy.
2. Briefly summarise how the concussion rule is applied in rugby league.
3. How will this policy enhance safe participation for all rugby league players?
4. Investigate one other sport you are familiar with. Check to see if it has a concussion rule and, if so, briefly describe how it is applied.

study on
Option 3 > Question 3 > Topic 2 > Concept 1
Rules of sports and activities Summary screen and practice question

study on
Option 3 > Question 3 > Topic 2 > Concept 2
Protective equipment Summary screen and practice question

study on
Option 3 > Question 3 > Topic 2 > Concept 3
Grounds, equipment and facilities Summary screen and practice question
11.3.3 Environmental considerations

Some environmental conditions, such as excessively high or low temperatures, humidity, wind and cold may place the athlete at risk. In some cases, climatic changes can occur quickly leaving the athlete unprepared. However, in most cases, athletes are aware of impending extremes within particular climatic zones and are able to take necessary precautions.

Appropriate hydration is probably the most important factor that needs to be considered in the case of endurance work. Lack of adequate fluid not only impairs performance but also could lead to serious health consequences. Athletes need to understand the basic principles of how the body regulates temperature and implement strategies for effective temperature control.

Temperature regulation

Our normal body temperature (the reference temperature) is 37 °C. This is the temperature inside the body (the core). It remains at 37 °C because a balance exists between the heat being produced by the body as a result of metabolism and muscle action and being dispersed by the body through specialised heat loss mechanisms, namely, convection, radiation, conduction and evaporation.

The hypothalamus, which is located in the brain, is the body’s thermostat. It reacts when the body’s temperature goes above or below its ‘set point’ of 37°C (see figure 11.40).

A small drop in body temperature, for example, may cause a person to shiver, which is an involuntary muscle action that raises body temperature. Figure 11.41 illustrates body responses that result from changes in core body temperature.
In healthy individuals, body temperature is kept within a small range despite large fluctuations in atmospheric temperature. The body continually produces and then loses heat. When the amount of heat produced is equal to the amount of heat lost, the body is in a state of heat balance. Figure 11.42 shows how the body maintains this balance.

The body has four mechanisms for losing heat. This is important during exercise as working muscles create considerable heat during contraction, which enables movement.

**Convection**

Convection is the transfer of heat away from the skin by a moving fluid such as an air current. A runner, for example, loses heat to the surrounding air as he/she moves through it. This accounts for approximately 12 per cent of heat loss at rest.

**Radiation**

Radiation refers to loss of heat in the form of infra-red rays. During activity, our body heats and a considerable amount of this heat is radiated to the atmosphere. The bigger the difference between the body’s heat and the environment, the greater is the radiated heat loss. At rest, radiation accounts for 60 per cent of heat loss.

**Conduction**

Conduction is transfer of heat from a body to an object by contact. For example, when playing tennis our feet contact the surface and conduct heat to it during the process. Heat loss occurs because a gradient exists between the body and the part of the environment with which it is in contact. When the environmental temperature is lower than body temperature, heat flows from the body. Conduction accounts for only a small amount of heat loss (approximately three per cent).

**Evaporation**

Evaporation refers to heat loss through sweating. The process of cooling is only effective if water evaporates. At rest, in a comfortable environment, sweating accounts for up to 25 per cent of heat loss. However, this is the major form of heat loss during endurance events and particularly if the environmental temperature is high, when heat loss through sweating can be up to 80 per cent.

Figure 11.43 illustrates how heat is lost when a person is at rest. Compare this with figure 11.44, which shows major sources of heat loss during exercise.
Climatic conditions
The effect of climatic conditions, including temperature, humidity, wind, rain, altitude and pollution, need to be understood as they have the potential to affect an athlete’s health and well-being.

Temperature
Performances in comfortable environmental temperatures usually do not present a problem for athletes as regular fluid intake is sufficient to avoid heat stress. However, extremes in environmental temperatures, namely excessive heat or cold require specific performance strategies to avoid hypothermia or hyperthermia. Hypothermia is a condition characterised by body heat loss that far exceeds body heat gain, resulting in subnormal body temperature. Hyperthermia is excessively high body temperature that is usually experienced in hot, humid conditions in which evaporation is unable to take place.

The resting body has the capacity to maintain core body temperature at 37 °C, even with an environmental temperature as high as 60 °C. However, exercise in the heat can make it difficult for the body to control its heat balance mechanism, causing the body’s water requirement to greatly increase. Sustained performance in high temperatures can lead to heat stroke as increasing blood volume becomes devoted to transporting heat rather than oxygen. Together with this, the body sweats more fluid than it is able to replace through drinking. These factors alone place considerable strain on the heat balance mechanism.

Performances such as skiing, surfing, endurance running, cycling and scuba diving in cold conditions may be equally hazardous. These are conditions that cause loss of body heat to the extent that the ability to maintain heat balance is jeopardised. When the internal body temperature decreases more than one degree Celsius, it results in the activation of heat conservation mechanisms — shivering and peripheral vasoconstriction.
Vasoconstriction is a decrease in blood vessel size, causing less blood to be supplied to the area that is serviced by that blood vessel. Shivering increases heat production, while peripheral vasoconstriction decreases blood flow to the skin, slowing heat loss.

Athletes exercising in the cold should be aware of how much clothing is appropriate for the activity. Athletes should not overdress when exercising in cold conditions because excess clothing stimulates sweating and bulkiness can inhibit performance. The moisture quickly evaporates, taking heat with it, causing the body to rapidly cool and chill. In cold environments, athletes with higher amounts of subcutaneous fat have more protection and thereby lose heat more slowly. Children are more susceptible to heat loss than adults.

In water where the temperature is higher than 32 degrees Celsius, core body temperature can usually be maintained if the individual is active. However, in cold water, the body quickly loses the ability to conserve heat, resulting in hypothermia. The heat loss process in cold water is more rapid than when surrounded by air. The combined effect of radiation and convection reduces body temperature four times faster in liquid than in air at the same temperature. For example, in water where the temperature is 15 degrees Celsius, the internal temperature of a body reduces by approximately two degrees per hour. This sudden decline quickly causes hypothermia.

**Humidity**

Environmental warmth and humidity limit the body’s ability to dissipate heat. While high environmental temperatures impede heat dissipation, humidity prevents evaporation. For this reason, exercise in times of high temperature and humidity is to be avoided because it places the athlete at greatest risk.

**Wind**

Wind is also a factor to be considered in heat loss. The combined effect of *convection* (air movement around the body) and *conduction* (transfer of heat to objects such as clothing) contribute to wind chill. This burning sensation on the skin can be further accentuated by increased cloud and humidity. Light clothing that covers most surface areas during running and cycling, wetsuits for surfing and full-body ski suits with face goggles are examples of attire used to prevent wind chill.

**Rain**

While rain might assist body temperature control during performances in warm to hot conditions, it may also adversely affect safety. Rain can affect visibility and this has the potential to impact on safety. This is particularly important in events such as cycling where the combination of speed, lack of traction and poor visibility can contribute to accidents.

**Altitude**

For most athletes, altitude is not a significant factor in terms of safety. As altitude increases, our ability to perform physical work is affected, particularly in endurance type events. You should expect a general reduction in aerobic capacity of 3–3.5 per cent for every 300 metres you ascend above 1500 metres. However, some performances that are short in duration such as high jump may benefit due to less resistance. At high altitudes, solar radiation is stronger, so the use of sun protection strategies such as sunscreen is necessary.
Pollution

Pollution can pose a safety hazard, particularly for those who train and perform in large cities and those who suffer from asthma and cardiorespiratory problems. Pollution increases airway resistance, causing irritation to the upper respiratory tract and reduced oxygen transport capacity in the blood. The most dangerous pollutant is carbon monoxide, which binds to haemoglobin in preference to oxygen, thereby inhibiting oxygen delivery to muscles. Ozone might also create a health risk as it can cause respiratory discomfort, nausea and eye irritations.

Safety and well-being is best enhanced by avoiding cigarette smoking, avoiding exercise during rush hours in cities and trying not to exercise when humidity, temperature and traffic pollution levels are high.

Guidelines for fluid intake

Approximately 57 per cent of the total body weight of the average person is water. However, the loss of even a small amount can affect athletic performance. The most important cooling mechanism during physical activity is the evaporation of sweat from the body. Sweat is transported to the skin from where it evaporates (water changes into vapour), cooling the body.

The role of water in temperature regulation is critical, particularly during exercise. It is important because blood plasma is 90 per cent water. A reduction in water lowers plasma levels and causes blood pressure to decrease. This results in less blood being available to the muscles, particularly to the skin (which is the body’s major heat outlet). Reduced plasma volume also affects the body’s circulatory function because plasma is the medium for carrying red blood cells, nutrients, carbon dioxide waste and hormones around the body.

The effect of exercise on the body’s fluid supply is to accelerate water loss through sweating, causing body temperature to rise. In response, some water is produced as the body metabolises carbohydrates to produce energy. However, local production of water, although valuable, does not keep pace with fluid loss. The loss rate can exceed the metabolic production rate by as much as 10 times. Even minimal fluid loss affects endurance performance. For distance runners, their pace falls by an estimated two per cent for each one per cent of fluid loss during an extended run.
Progressive water loss produces the following symptoms:

- one per cent loss (700 millilitres) — thirst
- five per cent loss — considerable discomfort and a decline in aerobic effort
- 10 per cent loss — a breakdown in coordination, with movements becoming difficult
- 20 per cent loss — is the upper limit of dehydration before death.

Sweating causes some loss of electrolytes, while continued profuse sweating leads to dehydration. Figure 11.47 provides a guideline on the type and quantity of fluid necessary to prevent the onset of dehydration. The information is particularly important for athletes working in hot, humid conditions and for young children.

**FIGURE 11.47 Suggested fluid intake before, during and after competition**

<table>
<thead>
<tr>
<th>Event type</th>
</tr>
</thead>
<tbody>
<tr>
<td>One hour or more of continuous exercise in normal conditions</td>
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</table>

**Before competition**

- At least 500 mL, 30 minutes prior to competition

**During competition**

- Drink 200 mL every 15 minutes, do not wait for thirst to develop
- Drink more in hot conditions
- Replace 80 per cent of fluid loss while still continuing to exercise

**What to drink**

- Water, if exercise lasts less than one hour
- Diluted carbohydrate/electrolyte drink, if exercise lasts longer than one hour
- No higher than eight per cent carbohydrate solution
- Non-carbonated
- Cold fluid, as this empties from stomach faster
- No alcohol
- Fluid that tastes good to encourage drinking

**Following competition**

- Use water, then carbohydrate drinks
- Replenish fluid regularly until:
  - body weight returns to normal
  - urine is clear

**Inquiry**

**Body temperature regulation**

1. Investigate how the four pathways for losing body heat control body temperature during exercise in:
   - high temperatures and high humidity
   - cold, windy conditions.

**Acclimatisation**

Acclimatisation is a training technique where an athlete experiences different climatic stressors, causing physiological adaptations to occur. Where athletes need to compete in a range of climates, such as country New South Wales and Cairns in northern Queensland, acclimatisation assists performance. Footballers from Northern Queensland may find difficulty with breathing and skill execution on cold evenings in Canberra, while Sydney footballers find the humidity of far north Queensland energy sapping.
Acclimatisation is about developing tolerance to expected performance conditions. It applies to heat, cold, humidity, wind and altitude. Acclimatisation is enhanced through exposure and training in the environment or a prefabricated environment providing a similar effect. Generally, acclimatisation to heat and humidity takes about five to seven days, whereas altitude acclimatisation may take two to three weeks depending on elevation differences.

**FIGURE 11.48** Training at altitude to enhance acclimatisation can be simulated using altitude rooms.

**SNAPSHOT**

**Running on thin air**

The 1968 Mexico City Olympic Games have had sport scientists’ minds racing for decades. It was an Olympics where some records were smashed beyond comprehension, and others were completely untouchable.

Why? The answer is up in the air. Literally. Mexico City sits 2240 metres above sea level where the high altitude and thin air can wreak havoc on the human body.

For Professor Chris Gore, Head of Physiology at the Australian Institute of Sport (AIS), understanding the effects of altitude has become a fixation.

‘It’s been my passion for 15 years. I think it’s fascinating and I’m always trying to find new ways to help athletes and coaches use altitude training more effectively.’

So what happens to the air at high altitudes to affect our bodies so much?

This is due to the effects of gravity (which keeps air close to the ground) and heat (as you get closer to the sun) which cause molecules to bounce off one other and expand. So as you reach higher altitudes, the air expands.

Any given volume of air is comprised of 79% nitrogen, 20.9% oxygen and 0.1% other gases such as argon and krypton. But as you get higher and higher above sea level, the pressure of the atmosphere decreases.

While the composition of the air stays the same, the expansion means that the air is ‘thinner’ — so in essence, at higher altitudes you inhale less oxygen and nitrogen molecules than you would at sea level.

This drives a cascade of physiological responses in the human body. To begin with, your body increases its heart rate and respiratory rate to increase the amount of oxygen taken in and circulated around the body. So for example, while an athlete might normally run with a heart rate of 150 beats per minute, at high altitude it might increase to 165.

Then the body begins to respond and adapt to the altitude (a process called acclimatisation). More than 200 genes are turned on in response to altitude, and one that is most commonly thought of is that which induces the creation of more red blood cells thereby increasing the amount of haemoglobin in the blood.

Haemoglobin is the protein that binds oxygen molecules to red blood cells. The more haemoglobin in the blood cells, the more efficient the cells will be at carrying oxygen around the body. This means that even though less oxygen is taken into the lungs, it is more easily transported to the muscles.

Finally, as you breathe faster and faster, the amount of carbon dioxide in the blood is reduced, which leads to the blood becoming less acidic. To counter this, the kidneys release blood bicarbonate to try to balance the PH level. For athletes, this is a big advantage since blood bicarbonate is the primary source of protection for muscles against lactic acid — the waste that builds up during exercise and leaves muscles feeling stiff and sore.
While most of the scientific world has focused on the benefits of more haemoglobin following altitude training, Professor Gore and his colleagues have looked at the range of other effects. His work has proven that muscle buffering capacity is improved and that blood lactate levels during exercise are lowered. Additionally, the AIS scientists have found that athletes become more efficient after altitude exposure. Just like high altitude natives, athletes are able to use less oxygen to do the same amount of work after they have been at simulated altitude.

The down side however, is that many of these physiological responses do not occur straight away. It can take days, even weeks for the human body to fully adapt to the effects of altitude and for athletes to reap the benefits of better muscle protection and more efficient oxygen transportation.

Scientists have determined that at high altitudes of 2400 meters plus, we inhale approximately three quarters of the amount of oxygen molecules that we would at sea level. This decreases as you go higher. As a reference, on the summit of Mount Everest (8848m above sea level) we inhale only a third of the amount of oxygen we would at sea level, which is not enough to sustain human life.

**Altitude Training at the AIS**

To simulate this low atmospheric pressure, enabling athletes to get the benefits of altitude training without having to travel to high altitude areas, scientists at the Australian Institute of Sport have developed an 'altitude house'. This house, comprised of 12 beds, bathroom, kitchen and a lounge, simulates what it would be like to live at high altitude. The AIS recreate the low pressure atmosphere of 2500 metres by changing the composition of the air within the house to approximately 85% nitrogen and 15% oxygen. The air is not thinner, but the presence of less oxygen is physiologically equivalent to being at altitude.

Athletes from endurance sports like cycling, rowing, race walking and swimming live in the house for 3–4 weeks at a time, a couple of times a year. At the same time, they maintain their standard training regime in the normal atmosphere in Canberra, which is 600 metres above sea level.

According to Professor Gore, this ‘live high, train low’ program enables athletes to reap the benefits of high altitude living, while still enabling them to train with the same intensity and frequency.

‘Australia is at a disadvantage to other countries because we don’t really have big mountains for our athletes to live or train on, so the altitude house allows us to simulate what other countries have already,’ Professor Gore said.

‘And this way we get similar benefits from the altitude house that we would get from natural altitude by flying the athletes to train in say Europe, but without having to sacrifice their access to their physios, doctors, nutritionists, friends and family.’

Some athletes use the house as preparation for events where they will be competing at high altitudes. Mainly however, coaches are using the ‘altitude’ house as a way to improve performance at sea-level events.

‘By living in the house for 12 hours or so a day, the athlete’s red blood cell counts increase, their haemoglobin increases. As well, their muscle buffering capacity, ability to handle lactic acid and their efficiency also improves. They can then use these factors to their advantage in training and competitions.

‘Overall, we’re talking about a 1–2% increase in performance, which mightn’t sound like much, but can be the difference between a medal and failing to qualify,’ Professor Gore said.

But the effects don’t last forever. For example, Professor Gore quotes a study where Kenyan runners who lived and trained in high altitude all their lives were taken to a low-altitude region of Germany to train. After 6 weeks they runners had lost 5% of their haemoglobin showing a relatively fast de-adaptation.

‘The verdict is still out, but we’re looking at benefits lasting for between 2–4 weeks for sea level athletes who return to normal sea level training.’

For Professor Gore, one of the most interesting things about altitude is its ability to both hinder and help athletes, depending on their event.

‘In cycling for example, the thin air means there is less drag, and in short stints in particular, athletes’ ability to absorb oxygen is not badly affected. This is true of almost all explosive events, including sprints, long jump and triple jump.'
‘But for endurance events, like the ones our altitude training athletes compete in, kayaking, rowing and race walking, they are hit hard by the lack of oxygen and the lack of air resistance means little,’ Professor Gore concluded.

Inquiry
Running on thin air
Read the snapshot ‘Running on thin air’, then answer the following questions.
1. What is meant by ‘air is thinner at higher altitudes’?
2. How does the body acclimatise to air at high altitudes?
3. How does Australia’s altitude house function to improve acclimatisation?
   - How long do the benefits of altitude training last?
11.3.4 Taping and bandaging

Taping and bandaging are important safety measures. When used as preventative strapping or for injury rehabilitation, they increase the safety and well-being of the athlete.

Preventative taping

Taping refers to the application of adhesive or non-adhesive strapping or bandages to a joint area to protect, support or strengthen the joint during movement. Sports that require agility, speed, power and strength can place considerable stress on joints. Examples of such sports are basketball, football, soccer and netball. These sports demand explosive movements and frequent changes of direction, so the joints periodically sustain high levels of stress. Under these circumstances there is considerable potential for injury. Taping in these situations is a preventative or prophylactic measure. The general principles of taping are summarised in figure 11.50.

FIGURE 11.50 Principles of taping

Taping principles

- Use non-elastic tape for support. Elastic tape is used mainly for compression bandages.
- Ensure that the joint is placed in a position where it can be stabilised.
- Always begin with anchors.
- To ensure evenness of tension, pull the tape off the roll, then apply.
- Overlap each application by half to two-thirds to ensure strength.
- Maintain even pressure and reapply if circulation is cut.
- Avoid creasing the tape.
- Avoid continuous taping; that is, tear and restart after applying each strip (except when closing down).
- With the exception of eversion (rolling out) sprains, always tape in the direction that will tighten the structures at risk. For example, if the injury is on the lateral side of the ankle, the tape should pull from the lateral side upwards towards the medial side.
- Completely cover skin around the area with tape.
- Always finish with locks.
- Remove tape using blunt-nose scissors to avoid risk of injury from incision.
The following method is prophylactic because it aims at preventing an injury. In this example, taping is used to prevent an inversion sprain, which is the most common form of ankle injury. In this injury, the ankle rolls laterally (to the side), causing a strain to the ligaments surrounding the lateral aspect (away from the body’s midline) of the ankle. Taping allows plantar and dorsi flexion (up and down movements), yet restricts inversion (rolling in) and eversion (rolling out) of the foot.

- **Positioning**: stabilise the ankle on a bench or table and shave the area to be taped. Set the ankle in a dorsi flexed position; that is, with the Achilles tendon fully stretched. Slightly evert the foot (roll it outwards) and adjust your height so that you are not bending excessively as you tape.
- **Anchors**: attach the first anchor 15 centimetres above the ankle joint. This should begin at the front of the foot and run obliquely around the lower leg, without creases, and overlap the beginning of the tape. Attach the second anchor below the first, overlapping by half.
- **Stirrups**: each stirrup begins with attachment to the anchor on the medial side (inside) of the leg. It is then taken over the back half of the ankle bone, under the arch of the foot and is joined to the anchor on the lateral side (outside) of the leg. Two stirrups are required. Each should overlap the previous stirrup by half to two-thirds.
- **Extra anchors**: apply two anchor strips to secure the stirrups.
- **Figure sixes**: begin by attaching the tape to the anchor on the inside of the leg and pull it down to the lower foot. Continue applying tape under the sole of the foot and then upwards and across the top of the foot. It will join the original tape, forming a figure six. Apply two or three figure sixes.
- **Heel locks**: begin on the inside of the heel. Apply tape across the top of the foot and underneath the heel. Continue coming up the medial side of the foot and extend around behind the heel, across the lateral ankle bone and the top of the foot. The tape finishes on the medial side of the foot attached to where it began. Apply a second heel lock in the same manner.
- **Close down**: beginning on the lateral side of the leg and on the lower side of the anchors, wind the tape around the leg, overlapping by one-third each time. Upon reaching the ankle, continue spiralling, but in a figure eight pattern that goes under the foot and around the ankle. Proper closing down ensures that all skin is covered and that the tape underneath is securely attached.

### Application

**Taping**

Working in pairs, practise taping an injured ankle using the technique illustrated in figure 11.51 and described in the text.
Inquiry
Learning to tape a specific injury
Choose another type of joint injury other than the ankle, such as the thumb or wrist. Research how to effectively tape this injury. You can find out how to tape a sprained thumb using the Taping (thumb) weblink in your Resources tab.
Describe the process and use illustrations to help. Share your findings with the class.

Taping for isolation of injury
Taping is often required after an injury has been sustained and may be necessary during the rehabilitation process. For example, an ankle injury may be healed, but requires testing in training. In cases such as this, support should be provided while the injured area becomes accustomed to the demands of full activity. Taping may also be required so that the athlete can participate in body conditioning exercises to maintain fitness as much as possible during recuperation.

Bandaging for immediate treatment of injury
Immediately an injury is sustained, some bandaging is essential. Using the RICER regime means that compression bandages are applied to restrict bleeding into the injured area; however, other bandaging may also be helpful. The type of bandaging necessary varies according to the location and type of injury sustained. However, bandaging at this point serves to limit the motion of the body part, usually by securing it to another body part. For example, a sprained thumb may need to be strapped and supported by the wrist, as illustrated in figure 11.52.

Inquiry
Taping for prevention and treatment of injury
Evaluate the role of taping in injury treatment and prevention. The Taping weblinks in the Resources tab may assist in accessing more information.
Form groups of three and discuss your findings.

Inquiry
Actions to prevent injury
Draw a mind map to summarise preventative actions that can be taken to avoid injuries during sport and exercise.

Resources
- Weblink: Taping (thumb)
- Weblink: Taping
11.4 Managing injury rehabilitation

CRITICAL QUESTION
How is injury rehabilitation managed?

Following appropriate injury rehabilitation procedures restores the athlete to their pre-injury level of fitness.

11.4.1 Injury management procedures

Rehabilitation is the process of restoring the athlete to the pre-injury level of physical fitness. It involves mobilisation, stretching, conditioning, taping, training and testing as part of the assessment process. It is important that a proper rehabilitation plan is followed through the various stages and that the injury is completely healed before recommencing competition. The time taken for complete recovery varies. However, where immobilisation was necessary or a previous injury has recurred, it is absolutely essential that the full recuperation takes place before recommencing competitive sport.

Progressive mobilisation

Following use of the RICER method (see sub-topic 11.1.2), it is important that movement be restored to the injury as soon as possible. This is referred to as progressive mobilisation and involves gradually extending the range of movement through which the injured part can be manipulated. This continues until the part is fully functional. The athlete must avoid any aggravation of the injury during rehabilitation as this will extend the healing period.

Graduated exercise

Graduated exercise involves:
- stretching
- conditioning
- achieving total body fitness.

It is important that the program of exercises is individualised to each athlete. Even though two athletes may have calf injuries, we should not assume that the healing process will be the same for both. Physiological and metabolic differences together with the effectiveness of specific exercises will influence the rate of healing and the time it takes to move to the next step.

Stretching

Stretching the injured area is important to ensure that it heals without scarring. Scarring shortens the muscle and makes it prone to further injury. The most appropriate form of stretching is proprioceptive neuromuscular facilitation (PNF) stretching, where the muscle is stretched and strengthened during safe movements. See sub-topic 11.3.1 for more information about PNF stretching and appropriate flexibility exercises.
Conditioning
A rehabilitation program needs to be individualised to the needs of the athlete. Because of differences in sex, age, genetics and, in some cases, existing chronic conditions, a conditioning program that is overly aggressive may do more harm than good and serve only to lengthen the recovery process.

Conditioning implies a build-up in fitness as a result of adaptations to gradual increases in physical stress. An effective conditioning process uses the overload principle to ensure that a greater than normal load is placed on the body. Adherence to the principle of progression is also important as this recognises an optimal amount of overload for each individual is achieved over the most advantageous time period. Periods of rest and recovery are followed by gradually increasing periods of work. Correctly used, the principle of progression ensures that the conditioning experience is pain free in the injured area.

The principle of specificity is also important. The conditioning regime needs to target general cardiorespiratory fitness together with increasing the need for strength, power and local muscular endurance around the injured area.

Total body fitness
Total body fitness is regaining the level of mental and physical fitness reached by the athlete before the injury occurred. The training program must progressively and gradually overload the muscle groups and energy systems so that the required adaptations are regained before competition is recommenced. In relation to rehabilitation these adaptations include:

- hypertrophy (increased size) of the muscles
- strengthening of tendons and ligaments
- increased capillarisation and subsequent blood flow to the injured area
- increased elasticity of fibres
- increased joint mobility
- absence of all pain
- full confidence in knowing that the injured area can handle match stress
- fully restored balance and coordination.

Training
With total body fitness achieved, full training can resume. Here the athlete is expected to participate in the full training program in a pain-free environment. This involves participating in warm-up, conditioning, drills, skills development exercises, tactics and cool-down.

Use of heat and cold
When to use heat and/or cold on injuries has always been controversial. Generally, cold can be applied for anything up to four days following injury and may be required at times following that to reduce inflammation. Heat is not generally used for two or three days after injury, depending on the injury type and extent of damage.
FIGURE 11.54 Details and examples of heat and cold applications.

Cold applications
Commonly used cold applications include:
- ice massage, where ice is rubbed gently over the injury for up to 15 minutes at a time
- ice water immersion, where the injured area is placed in a container of iced water for short periods of time
- vapocoolant sprays, which cool affected areas quickly and help prevent muscle spasms.

Heat applications
Thermotherapy is the application of heat in various forms to the injury. When internal bleeding has stopped (about 48 hours after the injury), heat may be used to:
- increase elasticity to the new fibres during the stretching process
- reduce pain
- reduce stiffness
- increase blood flow
- reduce inflammation.

Heat energy is transmitted through radiation, convection and conduction. It may be applied using superficial techniques such as heat packs, or penetrating therapies such as ultrasound. Commonly used methods for heat application include:
- moist heat packs containing silicate gel. These are applied to the injury, with towels used as insulators between the packs and the injury.
- whirlpool baths, where the injury is immersed in a small spa bath containing water at the desired temperature (may be hot or cold) and the injury massaged by the movement of the fluid
- contrast baths, where the water temperature is alternated after five minutes or so between hot and cold. This increases local circulation by causing vasodilation (from hot water) and vasoconstriction (from cold water) of the capillaries in the injured area.
- microwave diathermy, which is used to heat deeper tissue, particularly tissue with a higher water content such as muscle and blood. With a towel placed over the skin, the tissue surrounding the injury is heated to approximately 42 °C and this temperature maintained for a period not exceeding 30 minutes.
- ultrasound therapy, which uses high frequency sound waves to produce heat energy. This is more effective in denser tissue, such as bone and ligament.

Inquiry
Use of heat and cold
Imagine a player has received a sprained ankle in a soccer game. Suggest how heat and cold applications could be used in rehabilitation. Investigate current theories on when these techniques should be used with this type of injury.

Inquiry
Rehabilitation of sports injury
Choose two of the following sports injuries: hamstring tear, shoulder dislocation, knee strain. Outline how you would rehabilitate each injury and justify the procedures you would use.
11.4.2 Return to play

Injured athletes should not return to play until their injury has completely healed. Even then, specific procedures need to be followed and precaution taken to ensure the injury does not recur. In the case of head injuries such as concussion, a medical clearance is essential.

Indicators of readiness to return to play

Effective treatment and rehabilitation ensure that the healing process has resulted in measurable improvements to the injured area. These include:

- **elasticity.** The new tissue has been stretched, promoting lengthways elasticity and resultant flexibility.
- **strength.** The new tissue is strong and able to support the body in stressful movements.
- **mobility.** The athlete has gained full movement, particularly in terms of agility.
- **pain free.** The injury is pain free during both light exercise and strenuous work.
- **balance.** The injured person is able to balance his or her body on the injured limb. Until this function is achieved, the rehabilitation process is not complete.

Inquiry

Readiness to return to play

Research and evaluate tests that could be used to indicate an athlete’s readiness to play following injury. You may find the Muscle strain weblink in your Resources tab helpful.

Monitoring progress

To monitor progress, results from a pre-test taken before the injury occurred could be compared to those of a post-test taken after the injury was sustained. This establishes if the athlete has lost fitness components such as speed and agility. The tests need to incorporate sport specific movement patterns. For example, if knee ligaments were damaged, an agility test such as the Illinois test (see Outcomes 1) would be appropriate, while a grip strength or power test would be inappropriate.

Psychological readiness

Physical readiness is not sufficient in itself to allow an athlete to return to play. Psychological preparedness underpinned by confidence and a positive outlook is also important in preventing recurrence of injury. Determining psychological readiness may be difficult to establish by rehabilitation personnel. Some athletes may want to return to play well before an injury is fully recovered. Others might feel pressure to get back on the field of play even though they do not feel confident that the injury will withstand the pressure of full competition. Both of these situations invite re-injury. A balance between motivation, self-assurance and common sense is fundamental to a safe return to play.

Specific warm-up procedures

Athletes returning from injury must ensure they are fully warmed up and muscle groups have been properly stretched before training or playing a game. When returning from injury, the warm-up may need to be more specific to the injured area. For example, if a sprinter incurred a hamstring injury, additional stretching exercises to both quadriceps and hamstrings are recommended to ensure that muscle groups have been extended in a safe environment beyond what will be demanded of them in competition.
FIGURE 11.55 The muscle rehabilitation plan

<table>
<thead>
<tr>
<th>RICER</th>
<th>Stretching</th>
<th>Strengthening</th>
<th>Conditioning</th>
<th>Training</th>
<th>Return to play</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>Pain free limits</td>
<td>A. Isometric exercises</td>
<td>A. Basic skills</td>
<td>A. Game-like situation</td>
<td>A. Resume lower level</td>
</tr>
<tr>
<td>Ice</td>
<td>No bouncing</td>
<td>Pain free limits</td>
<td>Full range</td>
<td>Some pressure</td>
<td>Preventative taping</td>
</tr>
<tr>
<td>Ice</td>
<td>Hold 15-20 seconds</td>
<td>Hold 10 seconds</td>
<td>Low intensity</td>
<td>No direct opposition</td>
<td>Stretching</td>
</tr>
<tr>
<td>Ice</td>
<td>Progressively increase range of movement</td>
<td>Relax 10 seconds</td>
<td>Pain free</td>
<td>Re-establish fitness</td>
<td>Strengthening</td>
</tr>
<tr>
<td>Ice</td>
<td>Injured muscle tissue repairs itself with scar tissue</td>
<td>Repeat 2-3 minutes</td>
<td>Running</td>
<td>Increase intensity/duration</td>
<td></td>
</tr>
<tr>
<td>Ice</td>
<td>Scars shorten muscles</td>
<td>Progressively increase muscle length</td>
<td>Hitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice</td>
<td>Shortened muscles can easily tear again</td>
<td>A. Game skills</td>
<td>Kicking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Full range</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Low–medium intensity</td>
<td></td>
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<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Pain free</td>
<td></td>
<td></td>
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<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>No pressure/competition</td>
<td></td>
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<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Twisting</td>
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</tr>
<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Turning</td>
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<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Preventative taping</td>
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<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Stretching</td>
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<td>Ice</td>
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<td>B. Game skills</td>
<td>Strengthening</td>
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<td>Ice</td>
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<td>B. Game skills</td>
<td>Strengthening</td>
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<tr>
<td>Ice</td>
<td>Ice</td>
<td>B. Game skills</td>
<td>Strengthening</td>
<td></td>
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</table>

Source: Adapted from Sports Injury Prevention Plan, SIPP, Sport Science and Research Centre of the Cumberland College of Health Sciences, Beiersdorf Australia Ltd., North Ryde, © 1986, p. 18. Reproduced by permission of Beiersdorf Australia Ltd.

Return to play policies and procedures

The decision regarding when a player can return to play varies from one sport to another. In many amateur sports, individuals make a decision in consultation with their doctor, physiotherapist or sports trainer. At the professional level, policies normally exist that suggest a set of procedures be followed to prove that a player is free of injury. At this level, having players return to play only to suffer a recurrence of the injury can be expensive both monetarily and in terms of team performance.

Typical protocol for professional athletes may involve consultation, review of x-rays, discussion regarding the use of strapping/bracing, fitness assessment, specific test results and participation in a range of sport specific movements within a return from injury skills test. Even then, coaches and trainers use their own criteria to establish when the athlete is ready and the level of competition most suitable in consideration of the type of injury. However, this varies from one sport to another and depends on the type of sport and professionalism of the organisation.

Application

Designing a skills test

Choose any sport. Design a skills test to assess whether previously injured athletes are ready to return to competitive sport. Share your information with the class. Then select one of the tests and have each class member perform it. Evaluate the test and discuss your findings.
**Inquiry**

**Return to play policies and procedures**

Divide the class into small groups along the lines of sporting interests. Have each group choose one major sport such as rugby league, netball or basketball. Investigate policies and procedures that regulate the timing of return to play at the various levels of the sport; that is, amateur through to professional and children through to adults. Choose one person to report to the class.

Based on the information provided in the reports, conduct a class discussion relating to issues surrounding the policies and procedures. Focus questions should be:
1. Why aren’t these policies applied to all sports?
2. Where should ultimate responsibility lie in deciding when an athlete is allowed to return to playing sport?
3. Should athletes be allowed to use painkillers to allow them to compete when injured?

**Ethical considerations**

Pressure to participate in sporting events comes from a number of sources including team-mates and coaches. Some individuals feel the need to get back to the field of play quickly for financial reasons. Even when injuries have not fully healed, some athletes choose to take painkillers to allow them to play. Ethical questions need to be explored fully as poor decision making can have consequences that may impact on performance for a long time to come.

**Pressure to participate**

Often, and particularly in elite sports, the services of talented players are required before injuries have fully healed. Some players may have injuries heavily strapped, while others are given injections to prevent pain from pressure or impact on the injured area. Many coaches see players as commodities, the products of lucrative contracts, who need to be on the field of play to gain value for cost. Irrespective of financial binds, it is unwise and dangerous to insist on or pressure players to resume competitive sport before injuries have fully healed. Pain in an injury indicates tissue damage and is a warning that rehabilitation is necessary for further healing.

**Use of painkillers**

The use of painkillers to enable athletes to play important sporting matches is, unfortunately, a reality in many sporting competitions. While some painkillers such as paracetamol might be taken to address headache or soreness around bruises, the use of prescription painkillers by way of injection is an area of real concern.

Prescription painkillers are taken to mask pain that would normally be present during the activity. Pain is the body’s response to tissue or organ damage. It tells us that what is happening is causing harm and should be stopped. Painkilling injections desensitise injured tissue and set an environment for further damage without the athlete being aware of what is happening. This prolongs the healing process. If further rupturing occurs, permanent mutilation of fibres will occur.

While some athletes have a higher tolerance of pain than others, pain that causes us to moderate or alter movements that provoke the pain need to be addressed. Similarly, if pain becomes so intense that it becomes a focus at the expense of other thoughts, such as beating an opponent, movement should be stopped. Failure to do so will result in further injury and a much longer than expected rehabilitation program.

Choices about use of painkillers affect elite sportspeople more than everyday athletes. Key players in football matches and particularly grand finals have often been cited as using painkillers to ‘get through the match’. The decision usually rests with the individual in consultation with the team doctor, trainer and coach. But ultimately, it is the player whose future is at risk.
11.5 Topic review

11.5.1 Summary

- Sports injuries can be classified as direct, indirect, overuse, soft tissue and hard tissue, depending on the way the injury was caused and the type of tissue damaged.
- There are a number of different types of soft tissue injury including tears, sprains and contusions. The RICER method is recommended as the preferred form of treatment for soft tissue injuries.
Skin injuries include skin abrasions, lacerations and blisters. These may require cleaning, use of disinfectant and possibly bandaging.

The healing process of a soft tissue injury involves three phases — the inflammatory stage, repair and regenerative stage, and remodelling stage. The RICER method is the most appropriate way of managing the injury in the early stages.

The two most common hard tissue injuries are fractures and dislocations. These injuries require immobilisation and medical treatment.

The TOTAPS (talk, observe, touch, active movement, passive movement, skills test) regime is recommended in assessment of injury.

Some children have special medical needs. Referees, coaches and supervisors should have knowledge of conditions such as asthma, diabetes, epilepsy, overuse injuries and heat stress conditions.

Children can benefit from some forms of weight training. However, strict supervision and adherence to guidelines such as focusing on high repetitions with low resistance must be applied to reduce the risk of injury.

Adult and aged athletes may require sports medicine if an injury occurs during a performance. Aged athletes need to have medical clearances and be aware of their options and limitations, particularly those relating to heart conditions, joint mobility and fractures.

Female athletes have special requirements. Sports medicine requires knowledge of the effect of performance on eating disorders, iron deficiency, bone density and pregnancy.

Preventative actions play an important role in enhancing the well-being of athletes. Attention to pre-screening, skill, technique, fitness and general procedures such as warm-up, stretching and cool-down assist in injury prevention.

Sports policy and the sports environment need to support the well-being of athletes. Issues of importance that need to be addressed include rules for both adults and children, matching of opponents, protective equipment and the provision of safe grounds, equipment and facilities.

Body temperature regulation is maintained by the body continually producing and losing heat. Heat loss mechanisms include convection, radiation, conduction and evaporation.

Climatic conditions including temperature, humidity, wind, rain, altitude and pollution need to be considered prior to performance. The combination of high temperature and high humidity increase the level of risk, particularly in relation to endurance performances.

Fluid intake needs to be substantially increased before, during and after performance where the sweat rate is high.

A period of acclimatisation assists in adjusting to a new environment by improving tolerance to the expected conditions.

Effective sports medicine requires that injuries are handled correctly by using the appropriate procedures. Taping may be required. It is important that injuries are managed correctly, rehabilitated and tested fully before return to play.

Players should not return to play until their injury is fully healed, as further injury will make the healing process more difficult and protracted.

Many things should be considered before returning to play following injury. Being pain free, having full mobility, being able to perform sport specific movement patterns and being psychologically ready are the most important factors.

Return to play policies and procedures need to be developed and followed by sporting organisations in general.

Ethical considerations such as pressure to participate and use of painkillers need to be thoughtfully considered by athletes as recurrent damage to injured areas can cause long-term problems.
11.5.2 Questions

Revision

1. Explain the difference between direct and indirect injuries. (H8) (2 marks)
2. Explain the difference between a sprain and a strain. (H8) (2 marks)
3. Describe how the inflammatory response would function if a person incurred a contusion. (H8) (3 marks)
4. Complete the following table summarising common forms of skin trauma. (H13) (3 marks)

<table>
<thead>
<tr>
<th>Skin trauma</th>
<th>Definition</th>
<th>Treatment</th>
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</thead>
<tbody>
<tr>
<td>Abrasions</td>
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<tr>
<td>Lacerations</td>
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5. Outline the advantages of rest, ice, compression, elevation and referral in assisting recovery from soft tissue injury. (H8) (2 marks)
6. Explain the difference between soft tissue and hard tissue injuries. Using an example from both, discuss how each is managed. (H8) (3 marks)
7. Outline the signs and symptoms you would need to be aware of when diagnosing a suspected simple fracture. (H16) (2 marks)
8. Explain the difference between a dislocation and a subluxation. (H8) (2 marks)
9. Explain how the TOTAPS regime would be used in the assessment of a player whose ankle rolled outwards (suspected sprain) during a game of touch football. (H16) (4 marks)
10. Discuss three specific medical conditions that relate to children. Outline how each can be managed to promote safety and well-being in sport. (H8) (6 marks)
11. Outline the nature of overuse injuries. (H8) (1 mark)
12. Discuss the appropriateness of resistance training for young children. (H13) (3 marks)
13. Provide advice about the sports participation options available for aged athletes with heart conditions. (H17) (3 marks)
14. Discuss how eating disorders and iron deficiency would each impact on the well-being of a female athlete. Suggest strategies to address each problem. (H17) (5 marks)
15. Explain why pre-screening is an important preventative action in the physical preparation of athletes. (H8) (2 marks)
16. Discuss how warm-up, stretching and cool-down assist in prevention of sports injury. (H17) (5 marks)
17. Provide examples of how rules and equipment can be used to promote safe participation. (H8) (2 marks)
18. Select a sports policy. Analyse it to determine the degree to which it promotes safe participation. (H8, H13) (6 marks)
19. Investigate the degree to which protective equipment is used in your favourite sport. Discuss the barriers that exist that prevent full and proper use of protective equipment. Suggest interventions that will enhance safety. (H17) (5 marks)
20. Choose a sport or activity. Explain the changes that have been made to enhance the safety of children who play this sport. (H17) (3 marks)
21. Investigate the role of temperature regulation in enhancing safe participation in physical activity on hot days. (H16) (5 marks)
22. Discuss the impact of climatic conditions on safe participation in sport. (6 marks)
23. Evaluate the role of acclimatisation in preparing athletes for competition in different environments. (H8, H17) (6 marks)
24. Explain the role of taping in the prevention of injury. (H13) (3 marks)
25. Investigate current theories on the use of heat in injury management. Briefly outline your findings. (H16) (5 marks)
26. Explain the benefits of stretching and strengthening as part of a muscle rehabilitation plan. (H8) (3 marks)
27. Outline the indicators of readiness for return to play following injury. (H17) (2 marks)
28. Discuss the problems that might be caused by playing with injury. (H17) (5 marks)
29. Discuss the ethics of using painkillers to enable a person to participate in sport. (H17) (6 marks)
30. Choose a sport. Describe a physical test that could be used to indicate readiness to return to play. (H13) (3 marks)

Extension
Investigate and explain appropriate methods of taping for the following injuries: a dislocated finger, stretched lateral knee ligaments, tennis elbow. (H13) (9 marks)

11.5.3 Key terms

**anaemia** is a condition in which there is an abnormally low level of haemoglobin, resulting in less oxygen being available to tissues. *p. 438*

**asthma** is a condition characterised by breathing difficulty where there is a reduction in the width of the airways leading to the lungs, resulting in less air being available to them. *p. 428*

A **contusion** is caused by a sudden blow to the body; a bruise. *p. 419*

**dehydration** is an excessive loss of water. *p. 460*

**diabetes** is a disease in which the body does not produce or properly use insulin. *p. 429*

**direct injuries** are caused by an external force applied to the body, such as a collision with a person or object. *p. 416*

**dislocation** is the displacement of a bone at a joint. *p. 425*

**eating disorders** are characterised by behaviour such as purging, binge eating and starving. The most common eating disorders are anorexia nervosa and bulimia nervosa. *p. 437*

**epilepsy** is a disruption to brain function, causing a brief alteration to the level of consciousness and resulting in seizures or fits. *p. 431*

An **exercise prescription** specifies what we need to do to achieve a desired level of fitness. *p. 443*

A **fracture** is a break in a bone. *p. 417*

**hard tissue injuries** cause damage to bones and teeth. *p. 417*

**hyperthermia** is excessively high body temperature that is usually experienced in hot, humid conditions in which evaporation is unable to take place. *p. 457*

**hypothermia** is a condition characterised by body heat loss that far exceeds body heat gain, resulting in subnormal body temperature. *p. 457*

**immobilisation** restricts movement in the injured area by using splints and bandages. *p. 424*

**indirect injuries** are caused by an intrinsic force — that is, a force within the body. *p. 416*

**osteoporosis** is a type of musculoskeletal condition in which there is deterioration in the bone structure.

The bones become thin and weak, leading to an increased risk of bone fracture. *p. 435*

**overuse injuries** are caused by overuse of specific body regions over long periods of time. *p. 417*

**pre-screening** assesses the health status of a person before they become involved in a training program. *p. 443*

**soft tissue injuries** are injuries to all tissue other than bones and teeth. *p. 417*
sprains arise from the stretching or tearing of a ligament. *p. 418*

strains occur when a muscle or tendon is stretched or torn. *p. 419*

stress fractures are small incomplete bone fractures caused by repeated pounding, usually on hard surfaces. *p. 417*

thermoregulation refers to maintenance of a stable internal temperature independent of the temperature of the environment. *p. 432*

vasoconstriction is a decrease in blood vessel size, causing less blood to be supplied to the area that is serviced by that blood vessel. *p. 457*