Reference Material

Prevention and Recovery

Reference Material

National Coaching Certification Program

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The programs of this organization are funded in part by Sport Canada.

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TABLE OF CONTENTS

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The programs of this organization are funded in part by Sport Canada and the Public Health Agency of Canada. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada.

BACKGROUND INFORMATION

Sports injuries often seem inevitable, like death and taxes. But the truth is, many injuries are preventable. Success in prevention and recovery happens when coaches have a carefully prepared plan that they follow throughout the year. Effective prevention and recovery plans touch on all the modules that make up the Competition – Development context, and a well-thought-out Prevention Action Plan (PAP) results in improved sport performance when it counts.

For example, there is evidence that multiple intervention programs reduce injuries. Ankle sprains can be prevented by external ankle supports and proprioception/co-ordination training, especially in athletes with previous ankle sprains. Similarly, injuries to knee ligaments seem to decrease, especially in female athletes, when athletes train neuromuscular and proprioceptive responses and improve their jumping and landing technique. The most effective way to do this is to practise specific movement patterns such as the 12 PAK presented in this module.

Key Concepts

- The movement patterns presented in this module will improve your athletes' performance.
- Sport injuries that seem to come from out of the blue can be spotted from a long way off if you know where to look. Nagging recurring injuries can often be banished for good with the right approach.
- Recovery and regeneration strategies need to be planned the same way practices and workouts need to be planned. For example, you might schedule recovery time after each workout or schedule several hard workouts before allowing for recovery and regeneration. The latter is riskier than the former but may lead to greater adaptation.
- Prevention is both an art and a science. This module includes strategies that are best practices, given current research, and it encourages you to search for sport-specific innovations in movement patterns. After all, researchers often confirm the validity of systems that great coaches are already using.

This module is a resource for coaches working with Competition – Development athletes. The approach to sport injuries is broader than the traditional one, focusing on information, trends, and approaches that will help you prepare your athletes for competition, prevent injuries, and return athletes safely to competition if injuries occur.

The Prevention Action Plan

Guiding Statement

> Success depends on how well you train **and** how well you plan. This is true in performance enhancement, and it's also true in injury prevention. Performance enhancement and injury prevention are inextricably linked.

The starting point for this module is to ask coaches to list things they're already doing to prevent injuries, promote recovery, and maximize performance. These strategies may include prevention exercises, hydration breaks, scheduled recovery days, and nutrition counselling. The resulting listing forms the start of each coach's **Prevention Action Plan (PAP)**.

As you progress through this module, you will develop your own Prevention Action Plan.

INJURY TERMINOLOGY

Training for and playing any sport brings with it a risk of injury. This section describes the role of forces in injuries and defines the most common sport injuries.

The Role of Forces in Injuries

Athletic injuries occur when the forces applied to the body exceed the body's ability to absorb those forces. When this happens, structures start to tear.

Source of Forces

- Forces may be created **inside the body** by muscle contractions, especially eccentric contractions (see page 3) that are too powerful for the tendons (connective tissue).
- Forces may come from **outside the body**, for example, in the form of running into an object, being hit by another person, or landing over and over again.

How Forces Lead to Injury

- The energy created by forces inside or outside the body cannot be destroyed. So once energy enters the body, the tissues must absorb it.
- When the body cannot absorb the energy, injury occurs.

Nature of Forces

- Acute injury = Tissue damage that results from a single force from one contraction or one blow.
- Chronic injury = Tissue damage that results from repetitive forces over an extended period of time.

Types of Forces

- A **tension force** pulling or putting stretch on tissue that results in lengthening and tearing.
- A **compression force** crushing tissue that results in shortening and bruising.
- A **shear force** that results in lengthening and tearing.

Types of Injuries

The table below defines the most common injuries in sport by type of injury: sprains, muscle strains/pulls, and bruises.

Note: Terms in bold are defined in the table.

Anatomy/Injury Term	What the Term Means…
Ligament Sprains	
Sprain	An injury to a **ligament** that results from stretching the ligament beyond its elastic length, causing some or all of the **collagen fibres** to tear. The severity of the injury reflects the amount of force delivered and the number of fibres torn. Sprains are usually **acute injuries**.
Ligament	A band of tough, fibrous tissue consisting of many strands of **collagen**. Ligaments hold bones together. Ligaments also guide joint movement and limit movement in inappropriate planes. Ligaments tear (rupture) when joints are forced to move through a greater range of motion than the ligament can handle.
Collagen Fibres	The nylon-like fibres that make up **ligaments** and **tendons** in the same way that strands of fibres make up a rope. There may be hundreds or thousands of collagen fibres in a ligament.
Acute Injury	An injury with a rapid onset that can result from a single force. Ligament injuries are usually **acute injuries**.
Muscle Strains (Pulls)	
Strain	An injury to a **muscle** in which the muscle fibres tear as a result of overstretching. Strains are colloquially known as pulled muscles. The equivalent injury to a ligament is a **sprain**.
Muscle	The body's contractile tissue. To initiate **contraction**, muscle cells require a signal from the nervous system. Muscles cross joints, move joints, and protect joints by contracting when the joint is in a vulnerable position. However, muscles need to be trained to do this through a series of balancing or proprioception exercises.
Eccentric Muscle Contraction	A contraction that occurs when a muscle lengthens under tension. Such contractions are used to resist external forces such as gravity. The quadriceps muscles, for example, contract eccentrically when a person walks down steps, runs downhill, or lowers a weight. Eccentric contractions also occur during the deceleration phases of running. Training in which eccentric contractions predominate must progress gradually to minimize muscle soreness and control loads on muscle tendons.
Tendonitis	
Tendonitis (itis = inflammation)	The inflammation of a **tendon**. This tends to happen over time and therefore is considered a **chronic injury**.
Tendon	A tough cord similar to a **ligament**, except that it attaches muscles to bones. Tendons are injured when the forces developed by the muscle are more that the tendon can absorb. Tendons adapt more slowly than contractile tissue to high-power or high-speed training. Tendons are therefore more at risk than muscles from daily high-power, high-speed training. Tendon injuries are usually **chronic injuries**.

Anatomy/Injury Term	What the Term Means…
Stages of Tendonitis Pain	Tendonitis goes through several stages. It is beneficial if athletes or coaches catch tendonitis in the early stages and seek treatment before it stops the athlete from practising or competing. ❑ Stage 1: Pain after activity ❑ Stage 2: Pain at the start of and after activity ❑ Stage 3: Pain before and after activity with minimal pain during activity ❑ Stage 4: Pain continues between training sessions ❑ Stage 5: Pain interferes with performance ❑ Stage 6: The athlete has to stop altogether or the tendon ruptures
Chronic Injury	An injury that comes on slowly and can be long-lasting. These injuries usually require a careful examination of training, including volume, intensity, progression, and recovery strategies.
Bruises	
Contusion	Crushing of soft tissue that results in swelling that is usually blood based. It is possible to contuse any tissue that has a blood supply. While contusions mimic strains and sprains, they recover rapidly if managed properly.
Concussions	
Concussion	A concussion is a brain injury that cannot be seen on routine x-rays, Computed Tomography (CT) scans, or Magnetic Resonance Imaging (MRI). It affects the way a person may think and remember things for a short time, and it can cause a variety of symptoms. Any blow to the head, face, or neck, or a blow to the body that causes a sudden jarring of the brain may cause a concussion — for example, a ball to the head in soccer or a check from behind in hockey that causes a whiplash movement.
Mild Traumatic Brain Injury	Mild traumatic brain injury may cause temporary dysfunction of brain cells.
Post Concussion Syndrome (PCS)	PCS is a complex disorder where a combination of post-concussion symptoms (e.g., headaches, dizziness) lasts for weeks and sometimes months after the injury that caused the concussion.
Second Impact Syndrome (SIS)	The brain swells rapidly and catastrophically after a person suffers from a second head injury before the symptoms from the first have gone away. Although this condition is rare, it can lead to death.
Traumatic Brain Injury (TBI)	Traumatic brain injury can result in bruising, torn tissues, bleeding, and other physical damage to the brain. The result can be long-term complications or even death.

Source: Mayo Clinic (definitions of traumatic brain injury and mild traumatic brain injury).

FUNDAMENTALS ABOUT MAXIMIZING PREVENTION

Training Fundamentals

- Never train hard when stiff and sore
  - Whenever coaches introduce a new movement pattern at moderate intensity or increase movement pace significantly, some athletes are stiff and sore the next day. This stiffness and soreness is called Delayed Onset Muscle Soreness (DOMS).
  - If the athlete trains as hard as the day before, his or her movements may be uncoordinated, performance may suffer, and injury often results on the third day of hard training.
  - When athletes are stiff and sore, they need to train using the same movement pattern but at lower intensity until the soreness is gone (typically a few days) and then build up intensity again.
- Introduce new activities gradually
  - Skills that are complex, explosive, and powerful can cause the body to break down if they are repeated too often without a rest or a change to another movement pattern.
  - The art of coaching lies in recognizing when the athlete's body has had enough, when progress has turned to regression, when recovery time is needed, and when to forget it for today.
- Match increases in training with increases in resting
  - As training intensity increases, more attention needs to be paid to recovery techniques and to time away from high-intensity training.
  - Intensity can refer to high-power days or to high-velocity days. Such training days need to be followed by low-power or low-velocity days.
- Poor fitness levels cause injury
  - In multi-year programs for post-pubescent athletes, increased fitness levels need to precede increased skill levels by several months. Otherwise, athletes may get injured.
- Wear the right footwear
  - Athletic shoes are designed to share the forces the body absorbs during practices and competitions. When shoes play their role effectively, athletes are less likely to get injured.
  - Footwear qualities to consider include heel stabilization, arch control, midfoot control, uppers that are appropriate for the activity, absorption on heel landing, and midfoot absorption.
- Listen to your body
  - Athletes who know how to listen to their bodies can often feel the start of chronic injuries. Since little ones can become big ones, this is a valuable skill that can only be learned over time. The art lies in separating the discomfort that comes with hard training from the pain that signals danger ahead.

- Beware of the third week of heavy training
  - Psychological signs of fatigue and overtraining tend to rise dramatically around the third week of heavy training. This means it's time to change or reduce the training stimulus, focus on some other aspect of athlete development, and then resume heavy training.

Preparation Fundamentals

- EAP matters
  - Keep your Emergency Action Plan (EAP) up-to-date, and make sure it includes practice sites. For more information on Emergency Action Plans, see the NCCP's Planning a Practice module.
- Athletes need physicals too
  - Athletes should be screened by their family physician or a sports medicine physician for general health and athletic fitness before the start of each season.
- Walk the playing or practice surface for dangers
  - The playing surface needs to be checked before practices and competitions for unsafe conditions: debris, uneven surfaces, malfunctioning equipment, foreign objects, etc.
  - Report any conditions that could lead to injury, and make sure extra equipment and supplies are kept away from the playing area.
- First-aid/CPR certification is a must
  - At least one member of your support staff should be certified in first aid and CPR.
- The right equipment prevents injury
  - In many sports, equipment goes a long way to absorbing forces, thereby reducing the forces the body has to absorb and preventing injury.
  - You need to keep up with equipment standards, educate athletes and parents about equipment, and check equipment periodically.
  - Equipment needs to be appropriate for the sport, be of good quality, and fit properly.
- Use taping and braces when necessary
  - Taping can help prevent injuries, and so can properly designed and fitted braces.
  - Athletes benefit when their programs have access to certified sports medicine experts, who know how to tape and fit braces.
  - Many universities offer courses that can assist coaches with their taping and bracing skills.
- Hold a pre-season meeting with participants, parents, and support staff
  - Your Prevention Action Plan (PAP) will be effective only if it is implemented properly. Since your plan no doubt involves a number of people, everyone involved in your program needs to understand the plan as a whole and know how to execute his or her part of it.
  - Everyone also needs to understand that the PAP is a key part of athletes' performance program. A pre-season meeting that makes these points is essential.

12 PAK OF PERFORMANCE AND PREVENTION

This section identifies and describes how to perform 12 movement patterns. The 12 PAK is a group of movement patterns that, taken together, improve body control.

Body control is the basis of almost every sport skill, and the movement patterns that correspond to sport skills should be trained in the training phase BEFORE the skills are trained. Similarly, dynamic warm-ups in a practice should include the movement patterns that will be used in the sport skills that form the main part of the practice.

This 12 PAK of performance and prevention will improve sport performance and reduce the incidence of injury. In general, these movement patterns help athletes gain more control over their bodies, generate more power, and reduce the number of repetitions of skill training needed to perform at a higher level. In particular, these movement patterns:

- Help muscles protect joints from injury through improved proprioception
- Help muscles control the movement pattern of the leg when landing or accelerating
- Help the muscles of the body's core (lower back, abdomen, and hips) limit sway when skills are performed
- Help athletes improve balance and stability
- Help athletes improve their technique in sport-specific skills

Why 12? There's no magic to the number 12. There could have been 11, and there could have been 13 or more. For example, FIFA has developed a group of exercises called *The 11* for soccer (available at http://www.fifa.com/aboutfifa/developing/medical/the11/). The point is to improve body control, and these 12 movement patterns do it.

Variations? There are lots of variations of each movement pattern that would achieve similar body control. Coaches who have successfully used other movement patterns should share them with the other coaches in their group.

Progression? The 12 PAK was designed for athletes at the Train to Train and the Train to Compete developmental stages. If an athlete has trouble controlling a movement pattern, one option is to choose an easier version of the movement pattern. For example, with Dynamic One-foot Landing (12 PAK pattern #1), the athlete could follow this progression:

1. Standing in the landing position
2. Stepping into the landing position
3. Dynamic one-foot landing

Caution: As with all movement patterns or sport skills, athletes with growth-related injuries such as Osgood Schlatter's Disease or Little League Elbow may have to alter or omit movement patterns that aggravate the injury until the condition is resolved.

12 PAK Terminology

The table below defines the movement terms used in the descriptions of the 12 PAK on pages 10 through 21.

Movement Term	What the Term Means…
Proprioception	❑ *Proprioception* refers to reaction time in response to a change in joint position. This ability to sense the location, position, orientation, and movement of the body and its joints allows the muscles to be called into play. The muscles can then prevent the body from getting into positions associated with greater risk of injury.
Kinesthetic Awareness	❑ *Kinesthetic awareness* is the ability to know where your body parts are in three-dimensional space.
Proprioception/ Kinesthetic Awareness Training	❑ This training is common in the rehabilitation of injured athletes, but it is also effective in preventing joint injury. ❑ For example, an ankle can sprain when an athlete runs on uneven ground if the muscles aren't trained to react appropriately to the rough ground. Slight deviations in terrain require slight adjustments of balance to avoid injury. The movement patterns included in the 12 PAK are designed to prevent these injuries. The movement patterns may be done with the eyes open or closed.
Balance Training	❑ Why does balance matter? It's a basic skill needed in practically every sport. From soccer to tennis to rock climbing, changing the centre of gravity to match body moves is the key to efficiency in sport. ❑ Balance training improves proprioception and kinesthetic awareness. Balance also gets better, and the risk of injury decreases.
The Role of Muscle in Protecting Joints (ligaments)	❑ When joints start to move through a dangerous range of motion, muscles trained through balance training respond by contracting to control the range of motion.
Sway Reduction	❑ *Sway reduction* refers to reducing the back-and-forth or side-to-side movements that often occur during skill acquisition.
Core Stability	❑ *Core stability* is the ability of the lower back and hip to control abnormal sway and to return to normal from abnormal positions. ❑ Stability is achieved through muscle training.

Observing and Training the 12 PAK

Look for:

- ❑ Control of balance
- ❑ Absence of ankle wobble
- ❑ Limited knee sway
- ❑ Hips parallel to the floor
- ❑ Shoulders parallel to the floor
- ❑ Limited sway of the spine line
- ❑ Head looking straight ahead
- ❑ Equal contribution to movement from the right and left side

- Controlled deceleration or landing — it's just as important as acceleration

When training the 12 PAK, work to minimize errors in movement. One effective approach is to start with the core (spine line), work down to the foot, and then work up to the head.

When teaching sport skills, use the Coaching Focus sections of the 12 PAK descriptions to provide feedback on skill execution.

1. Dynamic One-foot Landing

Performance Enhancement	Injuries Prevented
❑ Improves stability, balance, proprioception, and kinesthetic awareness ❑ Reduces unnecessary movements during sport performance, making performance more efficient	❑ Ankle sprains ❑ Chronic knee injuries, including patello-femoral syndrome and chondromalacia ❑ Anterior cruciate ligament (ACL) sprains ❑ Other ankle, knee, hip, and trunk injuries
Starting Position	**Description of Movement**
❑ Stand with the feet shoulder width apart, chest and eyes facing forward	❑ Jump forward and land on one foot ❑ Hold the landing position for a minimum of 3 seconds ❑ Repeat 10 times ❑ **Note:** If the lateral rotators of the hip do not fire immediately, the hip, knee, ankle, and foot will cave in medially; this results in lost power and invites chronic injury to one or more of the above joints
Coaching Focus	**Progression**
❑ Limit sway at all joints from the core down to the foot (hip, knee, and ankle) ❑ Identify weak links by looking for excessive sway at specific joints ❑ Limit side-to-side movement at the knee, and keep the hips level ❑ Stand tall through the trunk	❑ Increase the distance jumped ❑ Increase the height jumped ❑ Land after stepping down from a step (start step height at 15 cm and progress) ❑ Think about sport specificity when developing progressions; for example basketball players benefit from landing from a height, whereas runners might benefit from more horizontal progressions



2. Walking Lunges

Performance Enhancement	Injuries Prevented
❑ Improves the strength of the push-off when running or jumping ❑ Can contribute to better control and efficiency during the push-off phase of running or jumping	❑ ACL sprains ❑ Hamstring strains ❑ Chronic knee injuries, including patello-femoral syndrome, chondromalacia, and jumper's knee ❑ Other hip, knee, and core injuries
Starting Position	**Description of Movement**
❑ Stand with good posture and the feet shoulder width apart	❑ Take a long step forward ❑ Drop the back knee toward the ground (until it's about 2.5 cm above the ground) ❑ Pull yourself forward onto the front leg, thinking about the front leg doing the work rather than pushing off with the back leg ❑ Repeat the movement with the other foot; as the motion becomes more fluid, it will look like walking with long, deep, exaggerated strides ❑ Start with 8 repetitions for each leg, and add reps as comfort with the movement increases
Coaching Focus	**Progression**
❑ Focus on good posture ❑ The front knee is above the front foot, does not dip in or out, and does not move forward much beyond the toes ❑ The toes of both feet point forward ❑ The shoulders stay above the hips throughout the movement pattern; those with weaker leg muscles may be tempted to lean forward over the knee to assist movement, but the core muscles (abdominals and lower back) should stay contracted to maintain good posture ❑ Movement is efficient; all movement is forward (avoids wasting energy by swaying)	❑ To further challenge proprioception, delay setting the swinging foot down, and transition right into the next stride ❑ Add trunk rotation to further challenge stability and flexibility and to practise sport-specific upper-body movements ❑ Pivot from side to side to practise sport-specific lateral movements ❑ Use dumbbells or other weights to focus more on strength gains
  	

3. Side Lunges

Performance Enhancement	Injuries Prevented
❑ Improves strength and control when pushing off laterally and moving laterally across a court or field ❑ Can contribute to better agility in sports that involve many changes in lateral movement and changes in direction	❑ Groin pulls ❑ Hamstring injuries ❑ ACL and other knee ligament injuries ❑ Other core, hip, knee, and ankle injuries
Starting Position	**Description of Movement**
❑ Assume an athletic ready position with the hands in front of the body, shoulders back, knees bent, hips pushed slightly back, shoulders above the knees, and weight centred above the balls of the feet	❑ Take a large side step, and then pull the feet back together using the lead foot to pull the trailing foot toward it ❑ As the movement becomes more fluid, it should look like a longer, deeper, exaggerated shuffle step moving laterally down or across the court or field ❑ Start with 8 reps in each direction, and add reps as comfort with the movement increases
Coaching Focus	**Progression**
❑ Focus on good posture and good balance ❑ Ensure the shoulders are always above the knees ❑ Ensure the knees are always above the feet when the feet are planted ❑ Minimize sway at the knee, hip, and trunk	❑ Pivot on each side step so that you face the opposite direction with each step



4. Walking Deadlifts

Performance Enhancement	Injuries Prevented
❑ Improves stability, resulting in more controlled movement patterns during sport and more efficient transfer of energy from the legs to the ground ❑ Strengthens the hamstring muscle and can improve running technique	❑ Hamstring strains ❑ Injuries associated with pelvic and lumbar instabilities ❑ Other injuries to the ankle, knee, hip, and lower back
Starting Position	**Description of Movement**
❑ Stand with good posture with the feet shoulder width apart	❑ Take a slow step forward and balance on the front foot ❑ Keep the arms out to the side for balance and body awareness ❑ Using an eccentric contraction of your hamstrings, reach toward the ground with your upper body ❑ Keep both legs straight until you feel a stretch through the hamstrings on the planted leg ❑ Return to the starting position by concentrically contracting the hamstrings on the planted leg ❑ Repeat with the opposite foot and continue for 6 repetitions on each leg ❑ Add reps once stable and confident throughout every repetition
Coaching Focus	**Progression**
❑ Keep the back very flat by thinking about reaching for the ground with the chest instead of with the head ❑ The hips and shoulders stay level as the athlete bends toward the ground ❑ Observe the range of motion — a bend in the planted leg or an inability to raise the back leg above parallel to the ground may indicate a shortened hamstring ❑ Watch for sway at each joint in the planted leg ❑ Watch for larger movements such as swaying forward to backward or side to side	❑ This is a very challenging movement pattern for most athletes ❑ Add reps once confident and stable throughout the entire movement ❑ To achieve eccentric strength gains in the hamstrings, hold weights in the hands

5. I, T, Y, W

Performance Enhancement	Injuries Prevented
❑ Improves the ability to stabilize the shoulder blades ❑ Creates a solid base to push or pull from	❑ Tendonitis, including supraspinatus tendonitis and biceps tendonitis ❑ Bursitis
Starting Position	**Description of Movement**
❑ Position the feet shoulder width apart with the knees bent slightly ❑ Bend the trunk forward so that the upper body is close to parallel to the ground or there is significant tightness in the hamstrings ❑ The arms hang straight down from the shoulders, and the lower back and abdominals contract to keep a neutral lower back posture	❑ I: Lower the shoulder blades, slowly raise the arms straight up above the head, and return the arms to the starting position ❑ T: Squeeze the shoulder blades together, slowly raise the arms straight out to the sides, and return the arms to the starting position ❑ Y: Squeeze and lower the shoulder blades, slowly raise the arms out to 45°, and return the arms to the starting position ❑ W: Squeeze the shoulder blades together, slowly bring the elbows back to the sides with the elbows bent at 45°, and return the arms to the starting position ❑ Motions are slow and controlled; take at least 4 seconds to form a letter and return to the starting position ❑ Start by forming each letter 3 times; add reps as the task feels easier, provided posture stays good and the shoulder blades complete a full range of motion
Coaching Focus	**Progression**
❑ The shoulder blades move down the back of the rib cage (depression) during the I, back together (retraction) during the T, down and together (retraction and depression) during the Y, and back together (retraction) during the W ❑ Watch for signs of fatigue; as athletes tire, they stand more upright or round the lower back, suggesting the core is unstable or the lower back is weak ❑ Observe which motions are most challenging; many athletes struggle with scapular depression, so watch that their I and Y stay high above their head and that they don't get closer to a T as they tire	❑ Once comfortable with 8 reps of the cycle of four letters, add resistance by using light weights, elastic bands/tubing, or a cable system

6. Push-ups

Performance Enhancement	Injuries Prevented
❑ Increase the strength of shoulder adduction and elbow extension, which can translate into stronger pushing motions ❑ May improve stability through the hand, wrist, elbow, and shoulder girdle, which can in turn improve the efficiency and strength of movements of the upper limb	❑ Shoulder dislocations and partial dislocations ❑ Injuries to the rotator cuff muscles of the shoulder ❑ Ligament injuries at the shoulder joint
Starting Position	**Description of Movement**
❑ The toes are on the ground and the hands are on the ground directly under the shoulders ❑ The back and legs are straight, and the arms and legs are fully extended ❑ Contract the abdominals and lower back to maintain a straight line between the heels and the top of the head	❑ Lower the body toward the ground in a controlled manner ❑ Stop when the elbows get to 90° or when the chest is about 5 cm from the ground ❑ Return to the starting position by extending the elbows ❑ Start with 8 reps, if possible, and increase the number of repetitions to 25
Coaching Focus	**Progression**
❑ The back and legs are straight ❑ The body position is stable, maintaining a straight line from the heels through the top of the head ❑ There is a full range of motion, but the elbows do not flex much beyond 90°, as this may stress the rotator cuff muscles of the shoulder	❑ Do push-ups with one or two hands on a half ball, wobble board, medicine ball, or basketball ❑ Do plyometric push-ups, pushing off more powerfully and catching yourself before pushing off again



7. Dynamic Plank

Performance Enhancement	Injuries Prevented
❑ Strengthens the core and enables the core to stay stable throughout sport movements, making energy transfer more efficient ❑ Produces strength and stability in the hip abductors, which can improve movement mechanics, as well as strength and stability during lateral movements and changes in direction	❑ Chronic lower back injuries ❑ Pelvic and lumbar instabilities ❑ Hamstring strains ❑ ACL and other ligament injuries in the knee ❑ Other lower back, hip, knee, ankle, and foot injuries
Starting Position	**Description of Movement**
❑ The toes are on the ground and the hands are on the ground, directly under the shoulders ❑ The back and legs are straight, and the arms and legs are fully extended ❑ Maintain a straight line between the heels and the top of the head by contracting the abdominals and lower back	❑ While in the push-up position, the back and legs are straight; hold this position for 5 seconds ❑ Keeping a plank-like posture, slowly rotate to one side until the shoulders and hips are aligned to one side and only one arm and one leg are touching the ground; the other leg is higher than its hip, and the other arm points to the ceiling; hold this position for 5 seconds ❑ This is a difficult movement pattern; if control cannot be maintained, keep the upper arm at the side, the upper leg close to the lower leg ❑ Rotate back to the central position, and hold this position for 5 seconds ❑ Rotate through to the other side, and hold this position for 5 seconds ❑ Focus on keeping a straight line in all planes throughout the movement ❑ Perform the series of planks 3 times
Coaching Focus	**Progression**
❑ Look for an *absence* of sway ❑ There is no extraneous movement, and the back and legs stay straight, forming a straight plank throughout the rotation ❑ The pelvis and lower back are in a neutral position (straight) throughout the movement ❑ The upper arm and leg are as high as possible; this challenges the abductor muscles	❑ Do the movement pattern on a dynamic surface such as a half ball or wobble board
	Modification
	❑ Start from the elbows instead of a push-up position
 	 

8. Supine Bridge

Performance Enhancement	Injuries Prevented
❑ Helps improve hip, pelvis, and trunk stability ❑ Strengthens muscles that extend the hip and the lower back (these muscles include the hamstring, gluteal, and lower back muscle groups) ❑ Improves strength and control in many sport-specific movements	❑ Chronic lower back injuries ❑ Hamstring strains ❑ Various hip and groin injuries
Starting Position	**Description of Movement**
❑ Lie flat on the back with the legs extended and the arms across the chest	❑ Bend both knees to position the feet flat on the floor or ground ❑ Push the feet into the ground to raise the body off the ground, and extend one leg ❑ Maintain rigid form, straight in all planes and forming a straight line from the shoulders through the knees to the raised foot ❑ Hold this position for 30 seconds, and try to increase this time
Coaching Focus	**Progression**
❑ Only the shoulder blades and the planted foot touch the ground during the up phase ❑ Body position forms a straight line from the head to the raised foot, and the pelvis and lower back are neutral (straight)	❑ Extend both legs completely, and raise the body by pushing the heels into a step that is at most 30 centimetres high ❑ To further increase the challenge of this variation, alternate lifting one leg a few centimetres off the step, or place the heels on an uneven surface such as a half ball, ball, or wobble board ❑ Variations that involve straightening the legs increase the load on the hamstrings relative to the gluteal muscle group and the muscles in the lower back ❑ The hamstring, gluteal, and lower back muscle groups work as a team to maintain hip and lumbar extension, so there are advantages to both variations



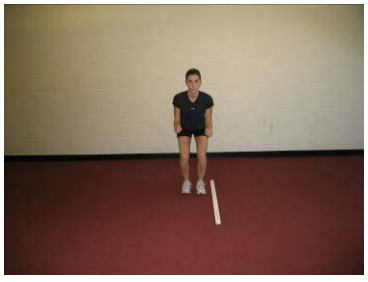
9. Zig Zag Run

Performance Enhancement	Injuries Prevented
❑ Improves agility by improving the eccentric strength needed to decelerate, the stability needed throughout changes in direction, and the power needed to accelerate in the opposite direction ❑ Decelerating well is as important as accelerating well	❑ Ankle sprains ❑ ACL injuries ❑ Other knee ligament tears ❑ Chronic knee injuries, including patello-femoral syndrome ❑ Many other soft-tissue injuries
Starting Position	**Description of Movement**
❑ Stand in an athletic ready position at the start of a pylon or tape course with pylons or tape on alternating sides of the court or field (~10m across and 10m down the field)	❑ Run in diagonal lines across the field or court ❑ Focus on the 3 phases of agility (deceleration, stability or change in direction, and acceleration in the other direction) ❑ Start slowly to **feel** the muscles work to stabilize from the ground through the foot, ankle, knee, hip, trunk, and shoulders ❑ Gradually increase the pace until you are moving through the drill as fast as you can ❑ Repeat the pylon course (10 pylons) 5 times
Coaching Focus	**Progression**
❑ Move fluidly and quickly from one direction to the next ❑ Minimize trunk sway ❑ Keep the knee over the foot and the shoulders over the knees	❑ Once proper mechanics have been achieved, work on minimizing the time it takes to change from moving quickly in one direction to reaching full speed in the other direction ❑ Make the drill as much like the athlete's sport as possible; for example, squash players would make many changes in direction in a very short distance, whereas tennis players would change direction less often but at a higher running velocity




10. Side Jumps over a Line

Performance Enhancement	Injuries Prevented
❑ Improves the strength and power of lateral movements ❑ Improves the ability to move laterally in a controlled and stable manner	❑ Ankle sprains ❑ Knee ligament sprains ❑ Chronic knee injuries, including patello-femoral syndrome and jumper's knee ❑ Various hip, knee, ankle, and foot injuries
Starting Position	**Description of Movement**
❑ Assume an athletic ready position with the knees bent, the knees above the feet, and the shoulders above the knees ❑ Stand to the side of a line on the ground	❑ Flex the knees and hips, and jump sideways over the line ❑ Immediately jump back across the line
Coaching Focus	**Progression**
❑ Monitor the body position ❑ On landing, the knees stay above the feet and don't dip in or out ❑ The shoulders stay centred above the knees, and there is little or no sway forward to back or side to side ❑ Focus on lateral movement; there should be little or no forward or backward movement on a jump ❑ As stability improves, the goal becomes minimizing the time spent in contact with the floor	❑ Jump over a barrier ❑ Do the drill on one foot ❑ Do multiple hops in different directions



11. Bounding

Performance Enhancement	Injuries Prevented
❑ Improves the strength, power, and stability of running and jumping	❑ Ankle sprains ❑ ACL sprains ❑ Other knee ligament sprains ❑ Chronic knee injuries, including patello-femoral syndrome and jumper's knee ❑ Hip and trunk injuries
Starting Position	**Description of Movement**
❑ Stand on one foot in an athletic ready position with the knees over the feet and the shoulders over the knees	❑ Bend at the knees and hips, and propel yourself forward onto the other leg ❑ Immediately jump back to the other foot. and continue forward down the field or court ❑ Start with 8 hops in each direction, and increase the number over time
Coaching Focus	**Progression**
❑ Maintain a stable position on each landing, with limited sway at the hip, knee, and ankle and throughout the trunk ❑ As stability improves, focus on minimizing contact time while maximizing the distance of each bound	❑ Bound over a barrier ❑ Add more lateral movement or more forward movement, depending on the athlete's sport ❑ Do two-foot jumps; determine which variation will train the movement patterns closest to the athlete's sport



12. Side Sliding on a Smooth Surface

Performance Enhancement	Injuries Prevented
❑ Improves the strength and control of push-offs in horizontal movements such as skating or moving laterally across a court or field ❑ Improves lateral mobility and speed	❑ Groin pulls ❑ Ankle sprains ❑ Knee ligament sprains ❑ Various other hip, knee, ankle, and foot injuries
Starting Position	**Description of Movement**
❑ Stand with the feet shoulder width apart, the knees bent, the feet under the knees, and the shoulders over the feet	❑ Slide to the side by pushing off from one side and shifting the weight to the other ❑ Immediately transition from one side back to the other by pushing off the other leg ❑ Make the movement 8 times in each direction, and progress to more reps as comfort increases ❑ Time goals are also appropriate for sports with similar repetitive movements (e.g., skating and hockey)
Coaching Focus	**Progression**
❑ Movement is smooth, fluid, and continuous ❑ The athlete looks stable throughout the entire motion ❑ Eliminate unnecessary sway at the ankle, knee, hip, and trunk	❑ Use only one leg to slide ❑ Slide on different surfaces; surfaces with more friction require greater force to move from one side to the other, whereas surfaces with less friction require more stability during the deceleration and change in direction
	Modification
	❑ Do lateral jumps instead of slides ❑ On landing, focus on controlling the deceleration



THE DYNAMIC WARM-UP FOR PERFORMANCE AND PREVENTION

A dynamic warm-up is 10+ minutes of activity that prepares athletes physically and mentally for practice or competition. Athletes should do dynamic warm-ups before each practice or competition because they:

- Improve performance
- Reduce the risk of injury

Dynamic warm-ups have several advantages over traditional static stretching. Effective dynamic warm-ups accomplish these seven things:

1. Increase heart rate more effectively
2. Increase muscle temperature
3. Improve force-generating capacity
4. Train neural pathways used in the athlete's sport
5. Provide the working muscles with energy from the energy systems used in the athlete's sport
6. Improve mental preparation
7. Help reduce the risk of injury

An effective dynamic warm-up has three components

1. *Active exercise*. Active exercise gradually raises the heart rate, increases muscle temperature, and improve range of motion.
2. *Dynamic stretching and body awareness*. The athlete activates muscles through a large range of motion, gains a better sense of balance, and develops body control.
3. *Sport-specific drills*. These prepare the athlete mentally and physically for participation in his or her sport.

An effective dynamic warm-up is specific to the athlete's sport

- *An effective dynamic warm-up uses the same muscle groups as the athlete's sport.* Example: Cycling does not increase muscle temperature in the upper body, so it would not be an appropriate warm-up for a discus thrower.
- *An effective dynamic warm-up trains the neural pathways required in the athlete's sport.* Example: While running uses the same muscle groups as cycling, the order in which the muscles are recruited is very different, so running would not be the best warm-up option for a cyclist.
- *An effective dynamic warm-up uses the same energy systems as the athlete's sport.* Example: Hockey relies primarily on anaerobic glycolysis to provide energy to the working muscles, whereas long-distance running requires mainly oxidative sources. The hockey player's warm-up should therefore include shorter, more intense bouts of skating interspersed with rest periods to mimic a typical hockey shift.

An effective dynamic warm-up prepares the athlete for sport without causing fatigue

- Effective warm-ups and fatigue have the opposite effect on certain aspects of sport performance:

Warm-ups…	Fatigue…
❑ Increase the ability to generate maximum force	❑ Decreases the ability to generate maximum force
❑ Increase the maximum velocity of contraction	❑ Decreases the maximum velocity of contraction
❑ Increase the maximum rate of force development	❑ Decreases the maximum rate of force development
❑ Decrease the time needed to "turn the muscle on" and "turn the muscle off"	❑ Increases the time needed to "turn the muscle on" and "turn the muscle off"
❑ Decrease the risk of injury	❑ Increases the risk of injury

- Three variables determine the effectiveness of a dynamic warm-up:
  1. The intensity of the warm-up activities
  2. The duration of the warm-up
  3. The length of time between the end of the warm-up and participation in the event
- If you alter one of these three variables, you must adjust the other two to produce the same results. For example, if you increase the intensity of the warm-up, you must either shorten the warm-up or provide more recovery time after the warm-up. And some variables may be easier to change than others. For example, the warm-up's duration and the length of time before the event may be set by event coordinators or referees. In such cases, you must adjust the intensity of the warm-up to match the other two variables.

Examples of Dynamic Warm-ups

Example 1	
Athletes:	Youth lacrosse team
Event: **Duration:** **Time between warm-up and event:**	Warm-up before a game 20 minutes 10 minutes
Active warm-up: **5 minutes**	❑ 5 minutes of jogging and ball handling ❑ Increase intensity gradually ❑ Mimic movement patterns in the sport ❑ Practise the skills necessary for sport performance at a lower intensity ❑ Make it fun!
Dynamic stretching and body awareness: **5 minutes**	Do two reps of each drill listed below, covering 20 metres on each rep; jog lightly back to the starting position between each rep: ❑ A walks/A skips ❑ B walks/B skips ❑ C walks/C skips ❑ Walking deadlifts ❑ Spider man ❑ Walking lunges ❑ Walking lunges with trunk rotation ❑ Side lunges ❑ Side lunges with pivot ❑ Kareoka (grapevine) ❑ Bounding with forward and lateral movement ❑ Sprints ❑ Backward sprints
Sport-specific skills: **10 minutes**	❑ Partner passing (gradual increase in distance) ❑ 1 on 0 ❑ 1 on 0 after breaking through a check ❑ 2 on 1 ❑ Goalie clear drill — players to get open, goalie to make pass ❑ Scoop on the run ❑ The gauntlet

Example 2	
Athletes:	Youth cyclist
Event: **Duration:** **Time between warm-up and event:**	15km time trial 50 minutes 5 minutes
Active warm-up: **5 minutes**	❑ 5 minutes of cycling on a trainer at 50% of VO_2 max ❑ Focus on a fluid and efficient pedal stroke
Dynamic stretching and body awareness: **5 minutes**	Do two reps of each drill listed below, covering 40 metres on each rep; jog lightly back to the starting position between each rep: ❑ A skips ❑ C skips ❑ Walking lunges with rotation ❑ Side lunges with pivot ❑ Step-ups with focus on stability ❑ Dynamic plank ❑ Linear jumps ❑ Bounding
Sport-specific skills: **(40 minutes)**	❑ 10 minutes at 50-60% of VO_2 max and 90-95 rpm ❑ 10 minutes tempo at 75-80% of VO_2 max and 75-85 rpm ❑ 2 minutes recovery at 50% of VO_2 max ❑ 6 minutes steady state 90-95rpm just below lactate threshold (80-85% of VO_2 max if not tested) ❑ 2 minutes recovery at 50% of VO_2 max, 90-95 rpm ❑ 2 minutes power intervals, 105 rpm (~90% of VO_2 max) ❑ 2 minutes recovery ❑ 2 minutes power intervals, 105 rpm (~90% of VO_2 max) ❑ 2 minutes recovery

Cool-down

An effective cool-down can speed up recovery following practice or competition, as it increases the rate at which the byproducts of exercise are removed from the working muscles. The accumulation of these byproducts can contribute to fatigue, but low-intensity exercise can help accelerate recovery by decreasing the concentration of these byproducts.

Accelerating recovery can have major effects on performance and injury prevention:

- The gains made in the rest period following a workout may be greater.
- The ability to perform in future events may improve.
- The ability to train harder during subsequent workouts may improve.
- The risk of injury may decrease, as fatigue predisposes the athlete to injury.

Principles of an Effective Cool-down

- The cool-down should consist of low-intensity aerobic exercise at 30-45% of VO_2 max or heart rate reserve.
- The cool-down should use muscle groups similar to those used in the athlete's sport.
- The cool-down should provide opportunities to slow down skills and focus on technique.

What about Static Stretching?

- There's no high-quality evidence to suggest that static stretching before or after sport activity reduces the risk of injury.
- So why would I use static stretching?
  - To improve sport performance in sports in which range of motion is important.
    - Example: Gymnasts and figure skaters improve how they perform some technical skills when they improve their range of motion AND may be judged on their range of motion.
  - To return muscles to their pre-exercise length. In sports that include many repetitive movements, muscles that are contracted repeatedly may become shorter over time. While this may benefit the specific skill being repeated, it may cause performance in other skills to suffer.
    - Example: In triathletes, frequent cycling can cause one of the quadriceps muscles to become shorter as the muscle adapts to cycling's flexed-hip position. This means the muscle is an optimal length during cycling, but running performance may suffer because the muscle is no longer the optimal length for running. Triathletes are encouraged to stretch their quadriceps muscles after cycling
  - To maintain or improve posture. Good posture minimizes the incidence of chronic injuries in the extremities. Static stretching over time helps minimize sciatica and thoracic outlet syndrome (a reduction of the space through which the blood vessels and nerves supplying the legs and arms pass), both of which are related to overuse injuries in the extremities. Improving posture often takes weeks or months of diligence. Muscles that are repeatedly contracted and become shorter over time can have a significant negative effect on posture.
    - Example 1: As described above, frequent cycling can cause the hip flexors to shorten, as can the defensive or receiving positions in sport. Shortened hip flexors in turn contribute to an anterior rotation of the pelvis. This rotation may increase the risk of lower-back, pelvis, and hamstring injuries.
    - Example 2: In sports like football, where athletes spend more time pushing than pulling, the shoulder spends a lot of time in a flexed, adducted, and internally rotated position. This in turn causes a shortening of the muscles that hold the shoulder in that position. This adaptation can result in a forward-shoulder posture that both increases the risk of shoulder injuries and may lead to thoracic outlet syndrome (see above). Athletes in these sports are encouraged to stretch the muscles that internally rotate and adduct the shoulder.
- How do I effectively use static stretching?
  - Static stretching should take place when the muscles are warm (usually after a practice or event).

- Static stretching should NOT take place before sports in which high-velocity or high-force muscle contractions are needed, because performance may suffer.
- It is important to balance opposing muscle groups when stretching and to balance both sides of the body.
- Athletes should feel only a mild stretch at the start of the stretch but should then feel a gradual release or elongation of the muscle.
- The number of repetitions and the duration of each stretch depends on the reason for doing the stretch. For example,
  - To increase range of motion: do 3 30-second repetitions
  - To return muscles to their pre-exercise lengths: do 1 30-second repetition
  - To improve posture: do 1 progressive stretch that lasts up to 120 seconds

SKILL EXECUTION FOR PERFORMANCE AND PREVENTION

Overuse Injuries in Power Skills

Overuse injuries in power skills frequently occur because athletes don't use the correct movement patterns. For example, athletes may underuse some body segments while overusing others or use body segments out of order (*big to small, use them all*). Such overuse results in chronic injury to those body segments.

The table below lists some common incorrect movement patterns in power skills, along with examples of these incorrect patterns.

Power skills include:

- ❑ Accelerating rapidly
- ❑ Decelerating rapidly
- ❑ Landing from a height
- ❑ Throwing, shooting, or serving for speed
- ❑ Resistance (strength) training or resisting an opponent

Here Are Some Common Incorrect Movement Patterns…	And Some Examples from Sport…
❑ Using one side of the body more than the other.	❑ Letting the dominant leg push harder than the non-dominant leg ❑ Pushing hard with the quadriceps but not pulling hard with the hamstrings on a cycling breakout
❑ Swaying from side to side or from back to front, or rotating without control	❑ Letting the spine line sway or collapse when landing from a height
❑ Not using the large body parts (trunk and hips), which are harder to control	❑ Not driving with the legs and trunk when throwing, shooting, or serving for speed or distance
❑ Relying on peripheral body parts to achieve accuracy	❑ Throwing a ball using only the arms and not the leg and trunk
❑ Rotating the trunk and hips too little	❑ Snapping the trunk too slowly or not at all when spiking the ball
❑ Using body part(s) out of sequence	❑ Rotating the shoulders forward at the same time as the trunk and hips in the softball swing

Observing Power Skills

Look for:

- ❑ Control of balance
- ❑ Absence of ankle wobble
- ❑ Limited knee sway
- ❑ Hips parallel to the floor
- ❑ Shoulders parallel to the floor
- ❑ Limited sway of the spine line
- ❑ Head looking straight ahead
- ❑ Equal contribution to movement from the right and left side

Athlete Self-coaching

Self-coaching can be an important part of athletes' development, as it gives athletes a better understanding of what they're trying to achieve. Self-coaching allows athletes to work on important parts of their skill execution when the coach isn't present or is working with other athletes. Here are some tools athletes can use to learn to coach themselves better and improve their skill execution:

- ❑ Videotapes
  - Watching best repetitions/performances from a number of angles
- ❑ Journals
  - Recording the thoughts, actions, feelings, lead-up drills, etc., that resulted in the best skill execution
- ❑ Visualizations
  - "Storing" their best performance in their mind and retrieving it before practising the skill
- ❑ Cue words
  - Attaching meaningful words to a movement pattern that resulted in the best skill execution
- ❑ Putting skills into words
- ❑ Explaining and demonstrating desired techniques to someone else

Skill Execution before Returning to Play

Whenever an injury occurs, coaches should put athletes through a series of progressive steps, starting with easy movement patterns and finishing with the sport-specific skill set at competition speed and intensity, before letting them return to play. This provides objective proof that athletes are ready to return and boosts their confidence. Otherwise, athletes may return to practice or competition too soon and re-injure themselves or injure another part of their body.

Functional Evaluation for Return to Play		
If the injury is to the leg(s), make sure the athlete can…	**If the injury is to the arm(s), make sure the athlete can…**	**If the injury is to the head, make sure the athlete…**

❑ Walk 10 metres slowly, then jog straight ahead slowly
❑ With support, raise and lower himself or herself on the toes, first on both legs, then one leg at a time
❑ Run 10 metres at half-speed straight ahead, then run 10 metres at half-speed going forward but periodically angling to the left and right
❑ Run a figure eight at half-speed over a 10-metre course
	❑ Slowly move the shoulder joint in a circular motion with large arm circles forward and backward
	❑ Bend and straighten the elbow joint, bend the wrist joint back and forth, and open and close the fist
	❑ Repeat the above with increased speed
	❑ Gently provide some resistance to the above movements with the other hand
		❑ Follows the Return to Play Guidelines:
		• Step 1: No activity, only complete rest.
		• Step 2: Light aerobic exercise.
		  • Symptoms? Return to rest until symptoms have resolved. If symptoms persist, consult a physician.
		  • No symptoms? Proceed to Step 3 the next day.

Functional Evaluation for Return to Play		
❑ Run a figure eight at increased speed over a 10-metre course ❑ Repeat these runs over a 5-metre course with tighter corners ❑ Run a straight line backward at half-speed for 10 metres ❑ Move in a sideways pattern, with stepping-over movements, first to the right and then to the left ❑ Simulate the common movements of his or her sport at slow speed, e.g., • Sprinting • Cutting • Changing direction • Bounding • Jumping ❑ Repeat the common movements of his or her sport at competition pace	❑ Attempt push-ups from a kneeling position ❑ Simulate the common movements of his or her sport at slow speed, e.g., • Catching • Lobbing • Throwing • Swinging • Hitting a mock ball ❑ Repeat the common movements of his or her sport at competition pace	• Step 3: Sport-specific activities. • Symptoms? Return to rest until symptoms have resolved. If symptoms persist, consult a physician. • No symptoms? Proceed to Step 4 the next day. • Step 4: Begin drills without body contact. • Symptoms? Return to rest until symptoms have resolved. If symptoms persist, consult a physician. • No symptoms? The time needed to progress from non-contact exercise will vary with the severity of the concussion and with the player. Proceed to Step 5 only after medical clearance. • Step 5: Begin drills with body contact. • Symptoms? Return to rest until symptoms have resolved. If symptoms persist, consult a physician. • No symptoms? Proceed to Step 6 the next day. • Step 6: Game play.

Remember:

- ❑ Being psychologically confident about returning to play is just as important as being physically ready to return to play. Injuries can be distractions if athletes aren't ready to return to play, and this can lead to poor performance or further injury.
- ❑ Don't let emotions rule; use a functional evaluation like that in the table above to make sure the athlete is ready to return to activity.
- ❑ Don't make poor and potentially damaging decisions about athletes' readiness to return to sport activities.
- ❑ Stop your functional evaluation as soon as the athlete experiences any pain or protects the injured area.
- ❑ Refer the athlete for medical attention if you are unsure about his or her return to play or if the athlete has any pain or is protecting a body part.

- Injured athletes often need to remain integrated with the group during their rehabilitation.
- Find ways for athletes to stay fit and train the uninjured parts of the body during the recovery process.

Note: When the injury is significant, athletes need clearance from their physician before returning to play. See the Return to Play Guidelines and the Concussion Guidelines for the Parents/Caregivers on the following pages.

Guidelines for Return to Play after a Concussion

GUIDELINES FOR RETURN TO PLAY AFTER A CONCUSSION

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A concussion is a serious event, but you can recover fully from such an injury if the brain is given enough time to rest and recuperate. Returning to normal activities, including sport participation, is a step-wise process that requires patience, attention, and caution.

Each step must take a minimum of one day but could last longer, depending on the player and his or her specific situation.

STEP 1: NO ACTIVITY, ONLY COMPLETE REST.
Limit school, work and tasks requiring concentration. Refrain from physical activity until symptoms are gone. Once symptoms are gone, a physician, preferably one with experience managing concussions, should be consulted before beginning a step wise return to play process.

STEP 2: LIGHT AEROBIC EXERCISE.
Activites such as walking or stationary cycling. The player should be supervised by someone who can help monitor for symptoms and signs. No resistance training or weight lifting. The duration and intensity of the aerobic exercise can be gradually increased over time if no symptoms or signs return during the exercise or the next day.

SYMPTOMS?	Return to rest until symptoms have resolved. If symptoms persist, consult a physician.
NO SYMPTOMS?	Proceed to **Step 3** the next day.

STEP 3: SPORT SPECIFIC ACTIVITIES.
Activities such as skating or throwing can begin at step 3. There should be no body contact or other jarring motions such as high speed stops or hitting a baseball with a bat.

SYMPTOMS?	Return to rest until symptoms have resolved. If symptoms persist, consult a physician.
NO SYMPTOMS?	Proceed to **Step 4** the next day.

STEP 4: BEGIN DRILLS WITHOUT BODY CONTACT.

SYMPTOMS?	Return to rest until symptoms have resolved. If symptoms persist, consult a physician.
NO SYMPTOMS?	The time needed to progress from non-contact exercise will vary with the severity of the concussion and with the player. **Proceed to Step 5 only after medical clearance.**

STEP 5: BEGIN DRILLS WITH BODY CONTACT.

SYMPTOMS?	Return to rest until symptoms have resolved. If symptoms persist, consult a physician.
NO SYMPTOMS?	Proceed to **Step 6** the next day.

STEP 6: GAME PLAY.

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Source: Parachute. *Guidelines for Return to Play after a Concussion*. Available at parachutecanada.org (www.parachutecanada.org/downloads/programs/activeandsafe/returntoplayguidelines.pdf).

Concussion Guidelines for the Parents/Caregivers

CONCUSSION GUIDELINES FOR THE PARENTS/CAREGIVERS

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WHAT IS A CONCUSSION?

A concussion is a brain injury that cannot be seen on routine x-rays, CT scans, or MRIs. It affects the way your child may think and remember things, and can cause a variety of symptoms.

WHAT ARE THE SYMPTOMS AND SIGNS OF CONCUSSION?

YOUR CHILD DOES NOT NEED TO BE KNOCKED OUT (LOSE CONSCIOUSNESS) TO HAVE HAD A CONCUSSION.

THINKING PROBLEMS	CHILD'S COMPLAINTS	OTHER PROBLEMS
• Does not know time, date, place, period of game, opposing team, score of game • General confusion • Cannot remember things that happened before and after the injury • Knocked out	• Headache • Dizziness • Feels dazed • Feels "dinged" or stunned; "having my bell rung" • Sees stars, flashing lights • Ringing in the ears • Sleepiness • Loss of vision • Sees double or blurry • Stomachache, stomach pain, nausea	• Poor coordination or balance • Blank stare/glassy eyed • Vomiting • Slurred speech • Slow to answer questions or follow directions • Easily distracted • Poor concentration • Strange or inappropriate emotions (ie. laughing, crying, getting mad easily) • Not playing as well

WHAT CAUSES A CONCUSSION?

Any blow to the head, face or neck, or a blow to the body which causes a sudden jarring of the head may cause a concussion (ie. a ball to the head, being checked into the boards in hockey).

WHAT SHOULD YOU DO IF YOUR CHILD GETS A CONCUSSION?

YOUR CHILD SHOULD STOP PLAYING THE SPORT RIGHT AWAY. They should not be left alone and should be seen by a doctor as soon as possible that day. If your child is knocked out, call an ambulance to take him/her to a hospital immediately. Do not move your child or remove any equipment such as helmets until the paramedics arrive.

HOW LONG WILL IT TAKE FOR MY CHILD TO GET BETTER?

The signs and symptoms of a concussion often last for 7-10 days but may last much longer. In some cases, athletes may take many weeks or months to heal. Having had previous concussions may increase the chance that a person may take longer to heal.

HOW IS A CONCUSSION TREATED?

THE MOST IMPORTANT TREATMENT FOR A CONCUSSION IS REST. The child should not exercise, go to school or do any activities that may make them worse, like riding a bike, play wrestling, reading, working on the computer or playing video games. If your child goes back to activities before they are is completely better, they are more likely to get worse, and to have symptoms longer. Even though it is very hard for an active child to rest, this is the most important step.

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CONCUSSION GUIDELINES FOR THE PARENTS/CAREGIVERS

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Once your child is completely better at rest (all symptoms have resolved), they can start a step-wise increase in activities. It is important that your child is seen by a doctor before he/she begins the steps needed to return to activity, to make sure he/she is completely better. If possible, your child should be seen by a doctor with experience in treating concussions.

WHEN CAN MY CHILD RETURN TO SCHOOL?

Sometimes children who have a concussion may find it hard to concentrate in school and may get a worse headache or feel sick to their stomach if they are in school. Children should stay home from school if their symptoms get worse while they are in class. Once they feel better, they can try going back to school part time to start (eg. for half days initially) and if they are okay with that, then they can go back full time.

WHEN CAN MY CHILD RETURN TO SPORT?

IT IS VERY IMPORTANT THAT YOUR CHILD NOT GO BACK TO SPORTS IF HE/SHE HAS ANY CONCUSSION SYMPTOMS OR SIGNS. Return to sport and activity must follow a step-wise approach:

STEP 1) **No activity, complete rest. Once back to normal and cleared by a doctor, go to step 2.**
STEP 2) **Light exercise such as walking or stationary cycling, for 10-15 minutes.**
STEP 3) **Sport specific aerobic activity (ie. skating in hockey, running in soccer), for 20-30 minutes. NO CONTACT.**
STEP 4) **"On field" practice such as ball drills, shooting drills, and other activities with NO CONTACT (ie. no checking, no heading the ball, etc.).**
STEP 5) **"On field" practice with body contact, once cleared by a doctor.**
STEP 6) **Game play.**
NOTE: **EACH STEP MUST TAKE A MINIMUM OF ONE DAY.** If your child has any symptoms of a concussion (e.g. headache, feeling sick to his/her stomach) that come back either during activity, or later that day, your child should stop the activity immediately and rest until symptoms resolve, for a minimum of 24 hours. Your child should be seen by a doctor and cleared again before starting the step wise protocol again.

WHEN SHOULD I TAKE MY CHILD TO THE DOCTOR?

Every child who gets a head injury should be seen by a doctor as soon as possible. Your child should go back to the doctor IMMEDIATELY if, after being told he/she has a concussion, he/she has worsening of symptoms such as:

1. **being more confused**
2. **headache that is getting worse**
3. **vomiting more than twice**
4. **strange behaviour**
5. **not waking up**
6. **having any trouble walking**
7. **having a seizure**

Problems caused by a head injury can get worse later that day or night. The child should not be left alone and should be checked throughout the night. If you have any concerns about the child's breathing or how they are sleeping, wake them up. Otherwise, let them sleep. If they seem to be getting worse, you should see your doctor immediately. **NO CHILD SHOULD GO BACK TO SPORT UNTIL THEY HAVE BEEN CLEARED TO DO SO BY A DOCTOR.**

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Source: Parachute. *Concussion Guidelines for the Parents/Caregivers*. Available at parachutecanada.org (www.parachutecanada.org/downloads/programs/activeandsafe/Concussion_Guidelines_for_the_Parents:Caregivers.pdf).

RECOVERY AND REGENERATION TECHNIQUES

Fatigue and Overtraining

Fatigue, overtraining, and recovery are all areas with many unknowns. Scientists have attempted to identify specific indicators of fatigue. Although many indicators have been identified, some athletes with these indicators perform at very high levels while other athletes with the same indicators perform poorly.

What is Fatigue?

Fatigue is a critical factor in athletic injuries: when athletes are tired, their bodies cannot respond to athletic demands and cannot avoid acute injuries. There is evidence that tissues are less elastic and therefore more predisposed to injury when fatigued.

Athletes walk a fine line between a training load that creates a positive adaptation and one that leads to breakdown. Athletes need to train hard on high-intensity days and recover hard on low-intensity days.

Before exploring various techniques for ensuring recovery, let's review the terminology.

This Term…	Means This…
Recovery	❑ The physiological processes taking place after exercise when the body is restored to its pre-exercise condition. Recovery processes include replenishment of muscle glycogen and phosphagen, removal of metabolites, reoxygenation of myoglobin, and protein replacement.
Acute Fatigue	❑ The muscle fatigue that occurs after strenuous training. Acute fatigue is considered normal following hard training; recovery occurs in 24-48 hours.
Chronic Fatigue	❑ The muscle fatigue that accumulates over time when there is not enough recovery. ❑ Chronic fatigue may occur after several days of hard training. It takes 3-7 days to recover from the resulting fatigue. This is a higher risk approach to using fatigue as an adaptation mechanism and must be monitored closely when used.
Overtraining	❑ Failure to recover from acute or chronic fatigue. Recovery from overtraining may take weeks, and overtraining may make it impossible for the athlete to peak as planned.

What is Overtraining?

Overtraining — aka staleness or burnout — occurs when athletes train intensely but do not recover from acute or chronic fatigue. Performance deteriorates instead of improving, even after an extended period of rest.

Signs and Symptoms of Overtraining	
Physical	**Emotional/Behavioural**
❑ Deteriorating performance*	❑ Depression
❑ Inability to maintain training load*	❑ Decreased self-confidence
❑ Chronic fatigue*	❑ Mood changes*
❑ Elevated resting heart rate*	❑ Apathy
❑ Slower heart-rate recovery	❑ Inability to concentrate
❑ Elevated blood pressure	❑ Anxiety
❑ Persistent muscle soreness	❑ Sleep disturbances
❑ Unexplained loss of body weight	❑ Irritability/excitability
❑ Headaches	❑ Boredom
❑ Heavy-legged feeling	❑ Loss of appetite
❑ Frequent illness (colds, flu)	❑ Excessive emotional displays
❑ Gastrointestinal disturbances	❑ Inability to relax
❑ Menstrual irregularities	❑ Anger/aggressiveness
❑ Decrease in power output over time	❑ Lethargy
❑ Low hemoglobin levels	❑ Low motivation
❑ Elevated resting lactic-acid levels	

*Signs and symptoms that, when considered together, appear to best indicate overtraining.

Note:

- ❑ Not all of these responses occur in any one overtrained athlete at any one time. There is great individual variation in the signs and symptoms of overtraining.
- ❑ Two of the most important signs of overtraining are a change in mood and a drop in performance.

Identifying Fatigue and Overtraining

Fatigue can have physiological, psychological, neurological, or emotional dimensions. As a result, identifying fatigue and responding to it is both an art and a science. The key is to collect information about athletes (signs) and from athletes (symptoms) and to interpret this information based on your experience and knowledge of the athletes.

Field tests and the Heavy Legs Index are good sources of information about athletes' fatigue and overtraining.

Field Tests

Field tests can indicate how athletes are managing their training load and the stresses in all areas of their life.

- ❑ Select the physiological parameter that is most important to your sport, e.g., sprint speed.
- ❑ Design a sport-specific distance and movement configuration that takes 6 to 10 seconds to complete and matches a competition situation.
- ❑ Test the athlete periodically to see if he or she is improving or regressing.

- If the athlete is regressing, you need to identify why and take action accordingly. The training load may need to be reduced while recovery takes place. Other recovery and regeneration techniques to consider are listed on page 39.

Heavy Legs Index

Another way to identify fatigue and overtraining is to use the Heavy Legs Index with your athletes:

- Determine the muscle group that fatigues first in your sport.
- Set a scale, for example, 1-10, where 1 = the muscle group feels great and 10 = the muscle group is totally tired OR establish a set of words that equals the scale of 1-10.
- Agree on how and when you are going to ask the athlete how the muscle group feels.
- Agree that this index is only one indicator of fatigue and agree on how this information will be used to design training load.
- If the score on the index is regressing, you need to identify why and take action accordingly. The training load may need to be reduced while recovery takes place. Other recovery and regeneration techniques are listed on page 39.

Understanding Responses to Training

The body needs time to adapt to repeated sessions of intense training. The things athletes do at rest are just as important as the workouts they complete. Quality training and quality rest are essential to top performance.

The challenge is to maximize recovery without jeopardizing the positive adaptations from training. Recovery is so important that banned substances have been created and used in an unethical manner to accelerate recovery.

Muscle Tissue Response to Training

Hard training creates microtears in the muscle fibres. The body normally repairs these fibres between workouts. But when hard workouts occur too close together, the body cannot fully regenerate. This may result in prolonged muscle fatigue, soreness, and sub-par performance. Taking time to recover helps athletes avoid muscle damage.

Connective Tissue Response to Training

Tendons adapt more slowly than muscle tissue, and it takes longer to regenerate tendon than to regenerate muscle.

Coaches need to:

- Pay close attention to work/rest ratios in practice and workouts
- Pay close attention to weekly schedules for practices, workouts, and competition
- Monitor daily for signs of fatigue
- Use field tests that measure/assess fatigue
- Include recovery techniques in daily, weekly, monthly, and annual plans

Athletes need to:

- Watch for the stages of tendonitis pain:
    - Stage 1: Pain after activity

- Stage 2: Pain at the start of and after activity
- Stage 3: Pain before and after activity with minimal pain during activity
- Stage 4: Pain continues between training sessions
- Stage 5: Pain interferes with performance
- Stage 6: The athlete has to stop altogether or the tendon ruptures

- Listen to their bodies for the early signs of tendon breakdown and alter their training or accelerate their recovery strategies if Stage 2 signs start to appear.
- Live an athlete's lifestyle. Give their body a chance to recover:
  - Sleep more and better to allow the body to repair itself
  - Develop a sense of when a pain or niggle calls for a day off; chronic soreness and signs that the pain is moving from Stage 2 to Stage 3 are good indicators that a day off is needed
  - Rest or cross-train at the first sign of an injury
  - Add core training to every workout
  - Honour the tapering plan
  - Eat strategically; nutrition provides the building blocks for recovery and repair, and this is how you build muscle; the workout alone does not accomplish this
  - Pre-hydrate and hydrate; fluid delivers nutrients to your body and removes the by-products of training
  - Do yoga to regain energy, improve breathing technique, and find inner peace

Recovery and Regeneration Techniques

Recovery and regeneration are areas lacking unanimous scientific agreement about the effectiveness of various techniques. However, some professions have used recovery and regeneration techniques for thousands of years, and coaches around the world currently use some or all of the techniques listed below.

Recovery starts with how you plan practices, schedule weeks, and approach competition. You need to schedule recovery within practices and within the week, and you need to be alert to the balance between hard competitions and hard practices.

Think of recovery techniques in terms of the active, psychological/emotional, passive, and postural techniques identified below, and combine them with any effective techniques you are currently using.

Active

- Recovery practices
  - Lower intensity practices, e.g., recovery runs for 30 minutes at a heart rate of 110-130 bpm or even less. These practices help remove the metabolic by-products of fatigue from the muscles by transporting them to the nearby aerobic muscle fibres and to the abdominal organs for recycling and removal.
- Work/rest ratios within a practice
  - Appropriate recovery time between work bouts. This will help prevent chronic fatigue and make possible quality repetitions.

- Periodized recovery and tapering
  - Structuring the practice, the week (microcycle), the month (mesocycle), and the year (annual sport plan). This creates opportunities for physical, psychological, and emotional recovery.
- Cross-training and recreational sport
  - Involvement in other sports during the off-season. This creates a physical and mental change of pace that allows athletes to rejuvenate.
  - A periodic cross-training or recreational session within a season of hard training. Such sessions can rejuvenate the athlete. One caution here is to keep the intensity low so that injury does not occur.
- Complete rest days or days off

Psychological/Emotional

- Psychological techniques for taking care of distractions and finding the right level of intensity. Acquiring these skills contributes significantly to reducing chronic injury and to improving performance.

Passive

- Massage
  - Manual massage. This is a long-established and effective recovery therapy used for the relief of pain, swelling, muscle spasm, and restricted movement.
- Contrast baths
  - Alternation of hot and cold water. For example, if the legs are fatigued after a hard workout, alternate between sitting in a hot tub for 3-5 minutes and sitting for 1-3 minutes in a cold tub with water at 13.9-12.8 degrees Celsius. The hot tub encourages blood flow to the fatigued muscles. The cold tub sends blood away from the fatigued muscles toward the heart and abdominal organs. This pumping action encourages recovery without the athlete having to do anything! If tubs are not available, sit or stand in a hot shower and then a cold shower for the times suggested above.

Postural

- Treatment and exercises to improve posture. Although perfect posture is often difficult to come by, better posture increases the flow of nutrient-building blocks to the muscles and maximizes the recruitment of muscles. Improved neck posture, shoulder position, and lower back posture are particularly important.

Recovery and Regeneration for LTAD

The following information on recovery and regeneration is from *Recovery and Regeneration for Long-Term Athlete Development*, a document on LTAD prepared by Canadian Sport for Life.


Active Start
Males & Females
0 - 6 yrs.
Fun and varied
activity everyday.
FUNdamentals
Males 6-9, Females 6-8 yrs.
Learn all fundamental
movement skills, play many
sports, focus on agility,
balance, coordination and
speed.
Learning to Train
Males 9-12, Females 8-11 yrs.
Learn overall sport skills as
cornerstone of many sports. Play
a variety of sports and develop
specific skills in three.
Training to Train
Males 12-16, Females 11-15 yrs.
Build endurance, develop speed
and strength towards the end of
the stage. Improve sport specific
skills. Focus on two sports.
Training to Compete
Males 16-23 +/-, Females 15-
21 +/- yrs. Optimize fitness
preparation and sport, individual
and position specific skills. Learn
to compete internationally. Focus
on one sport.
Training to Win
Males 19+/-, Females 18+/-
yrs. Ages are sport specific.
Podium Performances. One
sport.
Active for Life
Any age.
A smooth transition from
a competitive career to
lifelong physical activity
and participation in
sport.

Canadian Sport for Life

Table 1: Training and Competition Fatigue

Type of Fatigue	Main Causes for Fatigue	Expression of this Fatigue	Recovery Strategies
Metabolic Fatigue (energy stores)	• Training lasting one hour or more, or • From several (even shorter) sessions a day, & • It can be cumulative when training or performing over a number of days	• Athlete fatigues sooner than is normal for that athlete • Athlete struggles to complete a session or event	• Rehydrate & refuel before, during & after training • Use contrast temperature showers or pool or spa and cold plunge, or active recovery activities • Meal within 1-2 hours of training & monitor hydration
Neurological Fatigue (nervous system) **Peripheral Nervous System Fatigue (muscles)**	• After short high intensity sessions, e.g. weights, plyometrics, complex skill execution, etc. • After long but low intensity sessions especially involving repetitive movements, e.g. steady state swimming, running, cycling, paddling, rowing, etc.	• Reduced localized force production e.g. slow feet. reduced acceleration, poor technique, etc.	• Rehydrate & refuel (including small amounts of protein as well as carbohydrates) before, during & after training • Within 5 – 15 minutes after training use a spa or shower with jets focused on the large & fatigued muscles • After training or later in the day – massage large muscle groups using jostling / light shaking technique
Neurological Fatigue (nervous system) **Central Nervous System Fatigue (brain)**	• Low blood pressure levels • High pressured training session - especially involving rapid decision making & reactions • Poor motivation e.g. monotony of training, emotional factors, injury etc.	• Lack of drive • Lack of motivation	• Steady & regular intake of carbohydrates during training & after training to maintain normal blood glucose levels • After training – unwind, listen to music, visualization • Sauna – contrast hot and cold • Rest
Psychological Fatigue (emotional, social, cultural)	• Lack of team or squad cohesion, personality conflicts etc. • Competition pressures, event venue, residential conditions, parents, coach, media, etc. • Other lifestyle stresses – home, school exams, personal relationships	• Athlete looses self-confidence or self esteem • Poor interaction & deteriorating communication with other athletes & staff • Athlete's body language, increased signs of anxiety, negative attitudes, etc. • Quality of sleep is poor	• Focus on process rather than outcome performance measures • Debrief by identifying 1-3 things that worked well and 1-3 that need more work • Take mind off training with escapist or funny movie, TV, book, or socialize with family & friends • 10-15 minutes before bed switch off from the day by using relaxation techniques
Environmental & Travel Fatigue	• Disruption of normal routines, especially biological clock • Disruption to sleep, waking and meal times • Sedentary & limited body positions on long journeys, i.e. 30 minutes or more • Adapting to different climates and time zones	• Athlete takes longer to warm-up, are slower to start • Unforced errors in the first 15 minutes are well above normal • Athletes fatigue sooner than normal	• Preparation planning will minimise fatigue • Stay hydrated and refuelled • Stay cool in the heat - use a pool, shade, iced towels, etc. • Keep moving as much as possible on long journeys • Minimise visual fatigue by wearing sunglasses outside & limiting time on computers & play stations

Canadian Sport for Life

Table 2: Monitoring Strategies corresponding with athlete development and increased workloads and stress

Active Start & FUNdamental	Learning to Train	Training to Learn	Training to Compete	Training to Win	Masters Athletes & Coaches
Specific Training Age: 0 years	Specific Training Age: 1-2+/- years	Specific Training Age: 3-7+/- years	Specific Training Age: 8-10+/- years	Specific Training Age: 10-12+/- years	Specific Training Age: 1-100+/- years
At Training (C)* *Smiley Face.* • Energy / tired • Happiness **Reminder (C)** • Toilet (hydration) checks	**Start Recording (A)** • Energy / tired • Self-esteem • Quality of sleep • Illness or injury **Reminder (C)** • Toilet checks **6-9 months (C)** • Limited field and sports specific testing	**Daily Records (A)** • Resting HR • Energy / fatigue • Self-esteem • Quality of sleep • Muscle soreness • Appetite • Body weight • External stresses • Illness or injury • Menstrual cycle **Ongoing (A)** • Toilet checks **2-6 months (SS)** • Musculo-skeletal checks • Sports science & Medicine checks	**Daily Records (A)** • Resting HR • Energy / fatigue • Self esteem • Quality of sleep • Muscle soreness • Appetite • Body weight • External stresses • Illness or injury • Menstrual cycle **Ongoing (A)** • Toilet checks **2-6 months (SS)** • Sports science & Medicine checks **6-12 months (SS)** • Musculo-skeletal checks	**Daily Records (A)** *(as previous stage) Plus:* Individualized testing and screening varies for each sport and athlete (C & SS) Access to facilities and technology, plus the intensity of the competition schedule will influence when and how often testing and screening are done	**Daily Records (A)** • Resting HR • Energy / fatigue • Self esteem • Quality of sleep • Muscle soreness • External stresses • Illness or injury • Menstrual cycle (if relevant) **Ongoing (A)** • Toilet checks **6-12 month (SS)** • Sport Science & Medical checks **Annual (SS)** • Musculo-skeletal checks

* Monitoring responsibilities: (A) = Athlete: (C) = Coach: (SS) = Sport Scientist or Sport Medical Specialist

Left photo is courtesy of PacficSport Victoria

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Table 3: Recovery Strategies corresponding with athlete development and increased workloads and stress

Active Start & FUNdamental	Learning to Train	Training to Learn	Training to Compete	Training to Win	Masters Athletes & Coaches
Specific Training Age: 0 years	Specific Training Age: 1-2+/- years	Specific Training Age: 3-7+/- years	Specific Training Age: 8-10+/- years	Specific Training Age: 10-12+/- years	Specific Training Age: 1-100+/- years
During Training • Rehydrate every 20-30 minutes **After Training** • Drink (water, cordial, fruit juice) & light snack (e.g. fruit, muffin, or yoghurt, etc) • Light stretch • Shower at home	**During Training** • Rehydrate every 20-30 minutes **After Training** • Post game drink & snack • Active recovery • Light stretch • Shower • Meal within 2 hours **Before bed** • Self Massage • Stretching • Relaxation (TV, book, music)	**During Training** • Rehydrate every 20-30 minutes **After Training** • Post game sports drink & snack • Active recovery • Light stretch • Contrast shower • Meal ASAP **Before bed** • Self Massage • Stretching • Relaxation (as for previous stage) Plus: Progressive muscle relaxation, visualization, etc. **Weekly** • Sports massage • Active recovery (e.g. pool, golf, walk dog) • Spa & plunge pool • Stretching session (e.g. Yoga)	**Periodized recovery** *(as previous stage)* *Plus:* • Compressive skins post training • 2 massages a week • Strategies selected to suit specific fatigue (Table 1) • Recovery program individualized • Competition scenarios trialled • Especially recovery from travel fatigue and adjusting to different facilities • Increased range & use of psychological recovery (e.g. lotation, meditation) • Variety of active recovery and rest day activities	**Periodized recovery** *(as previous stage)* *Plus:* Detailed competition planning of recovery programs Fine-tuning recovery strategies for different competition environments Athlete has major input into the recovery program Variation in recovery strategies to prevent monotony	**During Training** • Rehydrate and refuel regularly **After Training** • Post game sports drink & snack • Active recovery • Light stretch • Contrast shower • Meal ASAP **Before bed** • Self Massage • Stretching • Relaxation movie, TV, book, music, visualization, meditation, etc. **Weekly** • Sports massage • Active recovery (e.g. pool, golf, walk dog) • Spa & plunge pool • Stretching session (eg. Yoga)

Photos on this page are are courtesy of Thomas Zochowski, PacificSport Victoria

Source: A. Calder. *Recovery and Regeneration for Long-Term Athlete Development*. Available at http://www.canadiansportforlife.ca/resources/recovery-and-regeneration-ltad.

Hydration, Nutrition, and Sleep

The Importance of Fluids

Proper hydration is important for all athletes to:

- Replace water lost as a result of sweating
- Avoid marked decreases in performance that result from dehydration
- Help maintain core body temperature within acceptable limits during exercise

The Effects of Dehydration on Performance

Dehydration negatively affects performance and is associated with premature fatigue. This is particularly the case for prolonged aerobic exercises such as distance running or cycling, but athletes competing in team sports or events of short duration can also be affected by dehydration.

Ironically, dehydration reduces the capacity of the digestive system to absorb water. Athletes should not wait until they are dehydrated before they drink, as this slows rehydration and causes gastric cramping.

Feeling Thirsty and Dehydration Level

It is well established that the sensation of thirst is not a good indicator of an individual's level of dehydration. When thirst manifests itself, approximately 2% of body mass has already been lost. Consequently, one cannot gauge dehydration by referring to the sensation of thirst. Therefore during exercise, it is important to drink on a schedule rather than according to thirst.

If thirst were the only point of reference used for determining fluid needs following profuse sweating, re-establishing optimum hydration could take 24 to 48 hours.

Drinking Fluids before Activity

Athletes should drink plenty of fluid every day, particularly before a practice session or competition. Athletes who are well hydrated have the following characteristics:

- Sweating that starts sooner and is more abundant
- An enhanced rate of absorption of the fluids consumed during exercise

In practical terms, this means drinking 1.5–2.5 cups (400–600 mL) of fluid 2 to 3 hours before exercise. This allows time for excess fluid to be excreted as urine before the exercise starts.

To ensure complete hydration, consuming 0.5–1.5 cups (150–350 mL) of fluid about 15 minutes before exercise is recommended.

Drinking Fluids during Activity

Amount of Fluids to Drink

Athletes should drink enough fluid to maintain fluid balance throughout the exercise. The amount of fluid an individual can tolerate during exercise varies from one person to another, but usually ranges between 10 and 15 mL per kg of body weight per hour. In other words, as the following table suggests, a 60 kg person can absorb between 600 and 900 mL of fluid in an hour, a 70 kg person between 700 and 1050 mL, etc.

Body weight (kg)	Approximate quantity of fluid absorbed by the body in one hour (mL)	
	from …	to …
30	300	450
40	400	600
50	500	750
60	600	900
70	700	1050
80	800	1200
90	900	1350

Rather than drinking large amounts of fluid at one go, it is better to drink 0.5–1.5 cups (150–350 mL) of fluid every 15 to 20 minutes, or as much as one can tolerate without feeling any discomfort.

Athletes rarely consume enough fluid to maximize the absorption capacity of the digestive system or to balance fluid losses. Increased fluid intake during exercise will improve fluid balance for most athletes.

Precautions

To encourage athletes to drink plenty of fluids, have them bring several bottles or containers of water or sport drinks. For reasons of good hygiene, do not allow them to share bottles or containers with other people.

Sport Drinks

Sport drinks containing carbohydrate are recommended for activities lasting more than 60 minutes without interruption. Several studies suggest an improvement in performance as a result of drinking sport drinks, which promote optimal performance by providing both fluids and carbohydrates.

When exercise lasts less than one hour, consuming a sport drink will probably not improve performance significantly. In this circumstance, drinking water should be adequate unless it is hot and humid, in which case a sport drink is recommended.

Strategy for Encouraging Hydration in Children

Recent studies show that children’s consumption of fluids is increased when drinks contain carbohydrates (40–80 grams per litre) and a little sodium. It is suggested that the coach encourage this type of drink rather than plain water to ensure that children take in enough fluids when they exercise in hot weather.

Rehydration after Activity

After an exercise where sweating has been profuse, it is extremely important to replace fluid. This sensation of thirst is not a good gauge. Consequently, forced hydration is often necessary.

It is possible to estimate how much fluid an individual has lost during exercise by weighing before and after the activity. The difference in kg represents the amount of fluid lost, in litres, since one litre of water weighs one kg. For each kg of body weight lost, at least 1.0 litre of fluid

plus an extra 0.5 litre should be consumed. It is important to drink more than one litre per kg of body weight lost to account for urinary losses.

The colour and amount of urine are an easy way for athletes to monitor their dehydration level. Scanty, dark urine signals a need for more fluid, in which case athletes should force themselves to drink more fluids. Plenty of clear-coloured urine usually indicates adequate hydration.

Hydration and Nutrition Before, during, and after Competition

The following information on hydration and nutrition was prepared by the Sport Nutrition Advisory Committee.

Fluids and Foods *BEFORE* Training/Competition

Pre-exercise nutrition provides:

- Energy
- Physical comfort
- Mental alertness

Targets:

- Optimal fluid intake
- High carbohydrate, moderate protein, and low fat

Why?

- To start exercise with optimal fluid levels.
- To prevent dehydration.
- To supply food that is quickly and easily digested.
- To ensure energy to train or compete.
- To prevent hunger before and during exercise.

Timing and meal/snack size are related.

Generally allow:

- 3–4 hours for a large meal to digest
- 2–3 hours for a smaller meal
- 1–2 hours for a small snack or blender/liquid meal or, whatever your own tolerance indicates

CAUTION: Spicy, gas producing, fatty, and/or fibre-rich foods may cause bloating or discomfort. Products containing caffeine have a laxative effect.

***BEFORE* exercise:**

- Drink 5–7 mL of fluid per kg body weight (about 300–500 mL) 4 hours prior.

- Drink 3–5 mL of fluid per kg body weight (about 150–350 mL) fluid about 2 hours before exercise, if you have not produced any urine or if your urine is still bright yellow.

- Eat a meal or snack, high in carbohydrate, 2 to 4 hours prior. Ideal carbohydrate foods include vegetables, fruit, juices, whole grains, milk, yogurt, soy drinks, and legumes. Legumes are fibre-rich and can be gas-producing.

- Include foods that contain some salt or choose a beverage with 0.5–0.7 g/L to help promote thirst and to retain the fluid.

- If you have a "nervous stomach" before events, choose juice, pureed foods (e.g. applesauce, mashed potatoes), lower-fibre grain products (cereal bar), or a meal replacement beverage.

Experiment with fluids and foods in training to find out what, and how much, is comfortable for you.

Never try new foods or drinks before or during competition.

CONVERSION: 250 mL = 1 cup = 8 oz.

***BEFORE* – Focus on Fluid and Carbohydrate**

Meal ideas – from home or on the go:

The amount and type of food will vary according to the amount of time available between the meal/snack and the start of training or competition. Allow time for digestion.

- Toast/bagel with jam, peanut butter, juice, yogurt
- Oatmeal/cereal, milk, raisins, juice
- Pancakes with a little syrup/spread, ham, juice
- Grilled chicken sandwich, juice
- Lean meat sandwich, carrots, milk, oatmeal raisin cookie, fruit
- Minestrone soup, cheese, crackers, vegetable juice
- Chili, bagel, milk
- Pasta with tomato/lean meat sauce, applesauce, chocolate milk
- Lentil soup, crusty roll, salad with a little dressing, soy beverage

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Comité consultatif sur la nutrition sportive

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Fluids and Foods *BEFORE* Training/Competition

Page 2

Snack ideas:

- Fruit (fresh, canned, or juice)
- Fruit yogurt
- Low-fat muffin, juice, or applesauce
- Yogurt, social tea biscuits, juice
- Pita with hummus, vegetable juice
- Fig or oatmeal cookies, fruit, milk

Snacks for backpack or car:

- Dried fruit
- Juice boxes or fruit cup
- Dry cereal
- Cereal, sport, or energy bars
- Crackers
- Trail mix with added raisins or cereal

From these guidelines, make a list of the drinks and foods that work for you.

- Plan ahead and be prepared.
- Carry pre-exercise food.

Avoid bacterial contamination of meals and snacks. Keep cold foods cold and hot foods hot. Bacteria reproduce quickly at room temperature.

Before exercise, choose foods which are higher in carbohydrate and lower in protein and fat. This will allow quick absorption of carbohydrate energy from the food into the body. Include protein and fat sources during meals and snacks at other times during the day.

For information on planning your meals and snacks, see these CAC resources:

- For an overview of your nutrition needs during training, refer to Training Diet: Everyday Eating.
- For a list of examples of high carbohydrate foods, refer to Energize with Carbohydrate!
- To learn how to meet your fluid needs during exercise, review Fluids for Athletes.
- To create a meal plan for your training needs, see From Training Diet to Meal Plans.

For help with planning your snacks before exercise, contact the dietitian at your Canadian Sport Centre or someone listed under the Sport Nutrition Registry on the CAC website. If there is no dietitian with expertise in sport listed in your area, Dietitians of Canada may list a dietitian near where you live.

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Fluids and Foods *DURING* Training/Competition

During exercise, nutrition provides:

- Energy
- Physical comfort; absence of hunger
- Mental focus for best technique and skill execution

Targets:

- Optimal fluid and electrolyte intake
- Carbohydrate to maintain blood glucose

Why?

- To prevent excessive dehydration.
- To prevent excessive changes in electrolyte balance.
- To avoid drinking more fluid than needed to replace sweat loss.
- To ensure energy to train or compete.

Fluid needs vary with your sweat rate, sport, and environment (temperature, humidity, altitude). Monitor your body weight changes during training and competition sessions to estimate sweat loss.

To find out how much is optimal and comfortable, test the amount and type of fluid and food in training – never during competition!

***DURING* exercise:**

- Drink freely from 0.4–0.8 Litres per hour.
- Drink more on days when you train harder.
- Drink more during hot, humid weather.
- Drink some fluid when training in cold weather.
- When training or competing for more than an hour, consume some carbohydrate (e.g. a sport drink or snacks).

Carbohydrate beverages: For sessions longer than an hour, carbohydrate helps maintain focus, technique, and energy. Aim for 0.7 g carbohydrate per kg body weight per hour (about 30–60 g carbohydrate per hour), taken at 15–20 minute intervals.

The recommended beverage for optimal fluid absorption during exercise has 40–80 g carbohydrate/L and 0.5–0.7 g sodium/L.

- Sport drinks provide water, carbohydrates, (40–80 g/L) and electrolytes (e.g. sodium, potassium).
- Fruit juice (100–160 g/L carbohydrate) needs to be diluted by half for rapid absorption and sufficient hydration during exercise.
- Energy drinks and soft drinks are too concentrated for rapid absorption and will slow rehydration during exercise.

You can make your own sport drink by mixing:

- 500 mL unsweetened orange juice
- 500 mL water
- 1.5 mL salt

One litre = 54 g (5.4%) carbohydrate and 0.5–0.7 g sodium.

Salt: Sport drinks contain salt (sodium), which is helpful for athletes training or competing for several hours and consuming large amounts of fluid.

CONVERSION: 250 mL = 1 cup = 8 oz.

***DURING EXERCISE* – Focus on Fluid and Carbohydrate**

Water is an effective fluid replacement drink for short (less than one hour) exercise sessions.

Athletes consume more when the fluid:

- Is easy to access (right beside them).
- Is a flavour they like.
- Is chilled (about 10 degrees C).
- Has sodium added (0.5–0.7 g/L enhances flavour and thirst).

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Fluids and Foods *DURING* Training/Competition

Snack ideas *DURING* prolonged exercise:

For training sessions lasting several hours and during competition, emphasize fluid and carbohydrate-rich snacks during rest breaks.

The amount you consume will vary according to the amount of time available between the snack and the next bout of exercise. Allow time for digestion.

During exercise or for short exercise breaks (less than 1 hour):

- Diluted fruit juice or a sport drink
- Fruit (dried, fresh, canned, or pureed)
- Bread, pretzels, or crackers and vegetable juice
- Cereal, sport, or energy bars
- Arrowroot, fig, oatmeal, or similar low-fat cookies
- Plain or chocolate milk or meal replacement beverage
- Fruit yogurt or fruit smoothie

For a longer break in exercise (1 to 2 hours):

- Juice and a bagel with peanut butter
- Yogurt, fruit, and water
- vegetable juice and a lean meat sandwich
- Fruit, cookies, and chocolate milk

For a small meal between practices or events (about 3 hour break):

- Fruit, cereal, and milk
- Fruit, vegetable soup, lean meat sandwich and milk
- Steamed vegetables, juice, rice, chicken or fish, yogurt

Avoid bacterial contamination of meals and snacks. Keep cold foods cold and hot foods hot. Bacteria reproduce quickly at room temperature.

During short breaks between exercise sessions, choose foods that are higher in carbohydrate and lower in protein, fibre and fat. This will allow for quick digestion and absorption of fluid and carbohydrate into the body, helping prepare you for the next bout of exercise.

- Plan ahead and be prepared.
- Carry snack items, or know where you can buy them.

For information on planning your meals and snacks, see these CAC resources:

- For an overview of your nutrition needs during training, refer to Training Diet: Everyday Eating.
- For a list of examples of high carbohydrate foods, refer to Energize with Carbohydrate!
- To learn how to meet your fluid needs during exercise, review Fluids for Athletes.
- To create a meal plan for your training needs, see From Training Diet to Meal Plans.

For help with planning your snacks before exercise, contact the dietitian at your Canadian Sport Centre or someone listed under the Sport Nutrition Registry on the CAC website. If there is no dietitian with expertise in sport listed in your area, Dietitians of Canada may list a dietitian near where you live.

SNAC Sport Nutrition Advisory Committee
Comité consultatif sur la nutrition sportive

Coaching Association of Canada
613-235-5000 www.coach.ca

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Fluids and Foods *AFTER* Training/Competition

Post-exercise, nutrition provides:

- Energy and nutrients to replenish fuel stores
- Rehydration for faster recovery
- Building blocks for muscle building

Targets:

- Optimal fluid and electrolyte levels
- Carbohydrate to restore muscle glycogen
- Protein to repair muscle damage
- Nutrients to support health and a strong immune system

Why?

- To replace lost fluid
- To replenish fuel stores
- To boost immune system
- To improve strength and endurance at the next event.

For rapid glycogen replacement, consume fluid and carbohydrate-rich foods as soon as possible after exercise, preferably within 30 minutes. Carbohydrate consumed in the hours after exercise moves readily into muscles to replace glycogen. Eating carbohydrate immediately after exercise also helps the body's immune system recover faster.

***AFTER* exercise:**

- Drink 1 ½ L of fluid for every kg of body weight lost.
- Consume some salty fluids and food for electrolyte (sodium) replacement and better fluid retention.
- Aim for 1.5 g carbohydrate/kg body weight within 2 hours after exercise.
- Choose a carbohydrate food that has a high glycemic index*.
- Have some lean protein food.
- Avoid skipping meals. Be sure to eat your next regular meal (breakfast, lunch, or dinner) within 2 hours.

* For information about the glycemic index of food, refer to Training Diet: Carbohydrate – Go Food.

The amount of food you consume immediately after exercise will vary according to the amount of time between your training or competition and your next scheduled meal or snack.

Late night *RECOVERY* nutrition:

It is never too late to eat your recovery meal. After an evening training session or competition, have a carbohydrate-based meal such as cereal with milk and fruit or a lean meat sandwich with juice.

CONVERSION: 250 mL = 1 cup = 8 oz.

***AFTER EXERCISE* – Focus on Fluid, Carbohydrate, and Protein**

After exercise, eat a snack immediately, followed by a balanced meal within 2 hours. Choose from all four food groups:

Vegetables and fruit	Grain products
Milk and alternatives	Meat and alternatives

Meal ideas – at home or on the go:

Plan foods to carry with you or food outlets where you can buy part or all of a meal.

- Fruit juice, bagel (with jam), yogurt
- Banana, juice, hot or cold cereal, milk
- Juice, english muffin with an egg and ham
- Carrot sticks, fruit, lean meat sandwich or sub, milk, oatmeal cookie,
- Minestrone soup, vegetable juice, bagel, cheese
- Baked potato, chili, milk
- Applesauce, juice, pasta, vegetables and meat sauce, bread roll
- Bean burrito with vegetables, chocolate milk
- Fruit, vegetarian pizza, milk

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Fluids and Foods *AFTER* Training/Competition

Page 2

Snack ideas: Pack snack items to have on hand. Some snacks can be part of your next meal.

- Fruit, cereal/cereal bar, milk/yogurt
- Tomato or fruit juice, pretzels
- Bagel, peanut butter, jam, chocolate milk
- Juice, yogurt, crackers or cookies
- Raw vegetables with hummus, milk
- Vegetable juice, canned beans and pita
- Fruit smoothie (fruit, milk, yogurt) and toast
- Fruit, sport or energy bar, chocolate milk

Snacks for backpack or car:

- Juice boxes or fruit cups
- Dried fruit, puree fruit cups
- Dry cereal
- Cereal, sport, or energy bars
- Crackers
- Tuna or beans in cans with pull-off tops
- Trail mix with cereal

Avoid bacterial contamination of meals and snacks. Keep cold foods cold and hot foods hot. Bacteria reproduce quickly at room temperature.

Try recovery fluid and food in training to find out what is comfortable for you. Never try new food or drinks if you will be competing within the next 48 hours.

For information on planning your meals and s nacks, see these CAC resources:

- For an overview of your nutrition needs during training, refer to Training Diet: Everyday Eating.
- For a list of examples of high carbohydrate foods, refer to Energize with Carbohydrate!
- To learn how to meet your fluid needs during exercise, review Fluids for Athletes.
- To create a meal plan for your training needs, see From Training Diet to Meal Plans.

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Sleep: A Key Factor in Recovery and Regeneration

Getting the right amount of sleep is just as important for recovery and regeneration as eating and hydrating properly. Sleep is also one of many variables that can give athletes an advantage over the competition.

Lack of sleep is also an important factor in sport performance. It can have negative effects on performance, slow down recovery, and compromise the immune system. Chronic sleep deprivation may increase the risk of injury and may even cause the body to store extra fat.

Signs and Symptoms of Sleep Deprivation

- Forgetfulness
- Time to exhaustion decreases
- Early fatigue during training or competition
- Unexpected emotional responses: pessimism, sadness, stress/anxiety, anger
- Inability to solve problems during practice or competition
- Decreased alertness and poorer focus on task
- Increased risk of not completing physical and intellectual tasks
- Slower recovery from training or competition or from injury

The Effects of Sleep Deprivation Depend On…

- Degree of sleep deprivation
- Duration of the athletic event
- Complexity of the athletic event
- Exertion required
- Level of fitness
- Body temperature (less effect on athletes with higher body temperatures)
- Amount of napping
- Overall energy deficit
- Stress levels
- Previous experience
- Gender (less effect on males)
- Age (less effect on younger athletes)

Factors that Contribute to Sleep Deprivation in Athletes

- Long road trips
- Crossing multiple time zones
- Part-time or full-time jobs while competing and training
- Consumption of caffeinated beverages and products
- Social activities while training and competing
- Long practice sessions

- Short time periods between training and competition
- Different training schedules after a long road trip
- Early-morning practices after a competition or hard practice the day before

Strategies for Avoiding Sleep Deprivation

Athletes should:

- Get two consecutive good nights of sleep before a competition
- Develop and stick to regular sleep habits that provide all the sleep needed
- Maintain regular eating habits — skipping meals or eating too big a meal just before bed can interfere with sleep
- Sleep more when they train more
- Take occasional 10-minute naps during competitions with multiple events
- Use training logs to monitor training and recovery — record key facts such as sleep patterns, motivation, feelings, physiological responses to training (e.g., resting heart rate), stresses (exams, work, etc.), and social activities
- Reduce their intake of caffeinated beverages and products

Coaches should:

- Build extra sleep and rest into road trips
- Alter the intensity and frequency of training on extended road trips
- Adjust training during unusually stressful periods such as final exams
- Ensure that injured athletes get lots of exposure to bright light (natural or artificial)
- Stick to recovery activities the day after a hard training day or competition, and do them later in the morning or day

For more information on sleep and recovery, see the information on the following pages.

SLEEP, RECOVERY, AND HUMAN PERFORMANCE

A Comprehensive Strategy for Long-Term Athlete Development

Post-exercise recovery and regeneration (PERR) is as important as the training regimen to the complex adaptive process of increasing athletic performance.[1] The foundation of PERR is sleep. Sleep constitutes the passive recovery, regeneration and rest process.

CANADIAN SPORT FOR LIFE

Charles H. Samuels, MD, CCFP, DABSM & Brent N. Alexander, M.Sc

Table of Contents

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Sleep, Recovery, and Regeneration

The effect of sleep on athletic performance has become a topic of great interest due to the growing body of scientific evidence that has demonstrated a relationship between critical sleep factors (sleep length, sleep quality and circadian sleep phase) and human performance.

Sleep Recommendations

Active Start

(Females & Males 0-6 years)

Duration: 13-16 hrs

Quality:
- Establish and maintain a sleep/ nap routine
- Ensure a comfortable/safe sleep environment
- Avoid stimulation 1-2 hrs before bed; minimize "screen time"

Phase:
- Consolidate nighttime sleep period
- Decrease naps to 1-2/day in the first year
- Natural light exposure first thing in the morning

Key Points:
- Establish stable sleep routines and a bedtime routine
- Use a sleep transition object
- Introduce independent sleep initiating behaviors

3

Sleep, Recovery, and Regeneration

The role of sleep and the importance of sleep in Long-Term Athlete Development (LTAD) is the focus of this section.

Sleep factors have also been shown to have a direct effect on metabolic processes including energy balance, appetite and weight control. More importantly, sleep extension and circadian rhythm research in athlete populations has provided objective evidence that confirms the significance of these relationships and importance of considering sleep in LTAD.

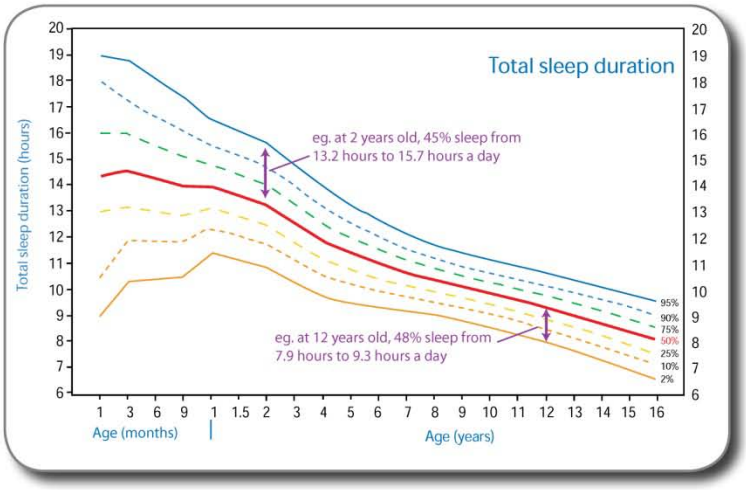
The relationship of sleep to PERR and performance can be viewed in a structured fashion. Sleep length (total sleep requirement: hours/night), sleep quality (sleep disorders, environmental disturbance or fragmentation), and sleep phase (circadian timing of sleep) are the key factors affecting the overall recuperative outcome of the sleep state. These three parameters of sleep affect an athlete's ability to train, maximize the training response, and recover. Most importantly, these parameters change over the course of an athlete's career and life. Therefore, the athlete, parents and coaches have to have strategies to adjust to the changing sleep requirements throughout the athlete's career. **Finally, attending to the importance of sleep will reduce the risk of overtraining/under-recovery, enhance resistance to illness and improve recovery from injury.**

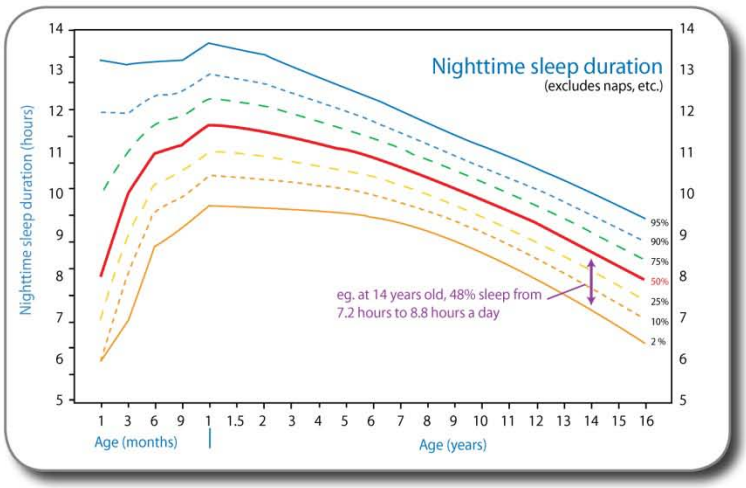
There is great interest and debate over the optimum amount of sleep (sleep length) required for humans to recuperate and function normally. Sleep requirements change over the course of an individual's life (figures 1 and 2). Figures 1 and 2 describe the general patterns of changes in sleep requirements and composition (sleep stages) over the course of a lifetime and provide sleep researchers/educators with the information to guide the advice provided for the athletes. It is a safe assumption that based on training demands the sleep requirement for an athlete would be greater than for the average individual who is not an athlete.

Therefore, establishing guidelines for athletes at various stages in their career development for sleep requirement, providing tools to assess sleep patterns/routines accurately and implementing strategies to achieve the recommended amount of sleep are important practical interventions. It is very important for athletes, parents and coaches to be aware of the fact that at the time in life (12–18 years old) when adolescents require the most amount of sleep (9–10 hours per night) they tend to develop a delay in their biological clock (circadian sleep phase) that reduces the amount of time available for sleep. This results in a chronic sleep restriction during a time of increasing training demands, growth and development.

Sleep Length

Figure 1 a & b. **Percentiles for total sleep duration** and nighttime sleep duration per 24 hours from infancy to adolescence. Adapted from Iglowstein et al. [3]





Sleep Recommendations

FUNdamentals

(Females 6-8, Males 6-9)

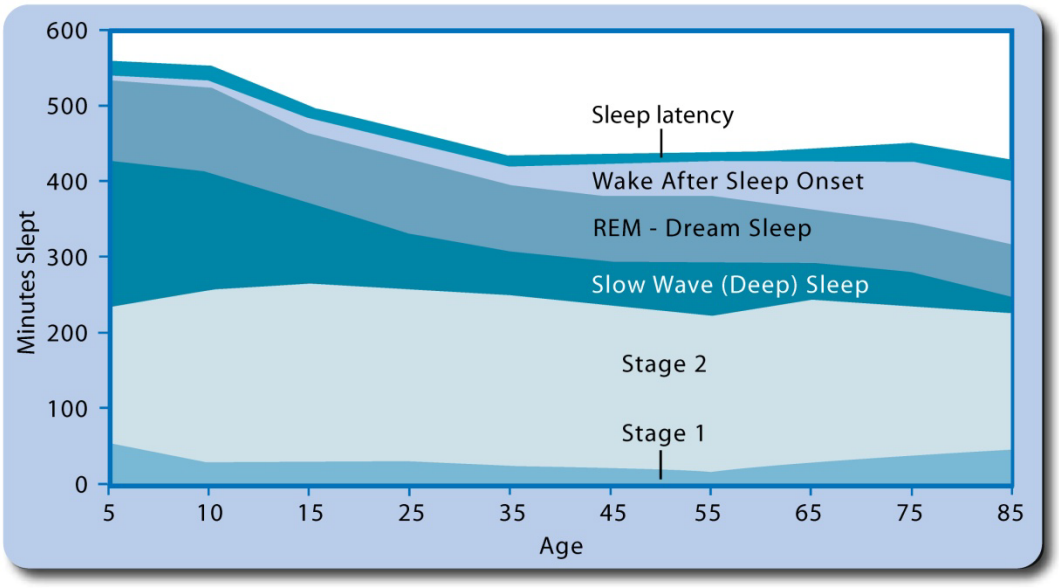
Duration: 10-11 +30 min nap between 2-4pm

Quality:
- Maintain a regular sleep/nap routine
- Ensure a comfortable sleep environment
- Establish independent sleep initiating behaviors
- Observe sleep for sleep disorders

Phase:
- Establish a neutral sleep pattern between 9pm and 8am.
- Encourage predictable afternoon nap/rest
- Establish reliable meal routines (breakfast is the most important meal of the day)

Key Points:
- Reinforce 15-30 min bedtime routine
- Avoid stimulation 1-2 hours before bed, control "screen time"
- Good nutrition and meal routines reinforce sleep routines object
- Introduce independent sleep initiating behaviors

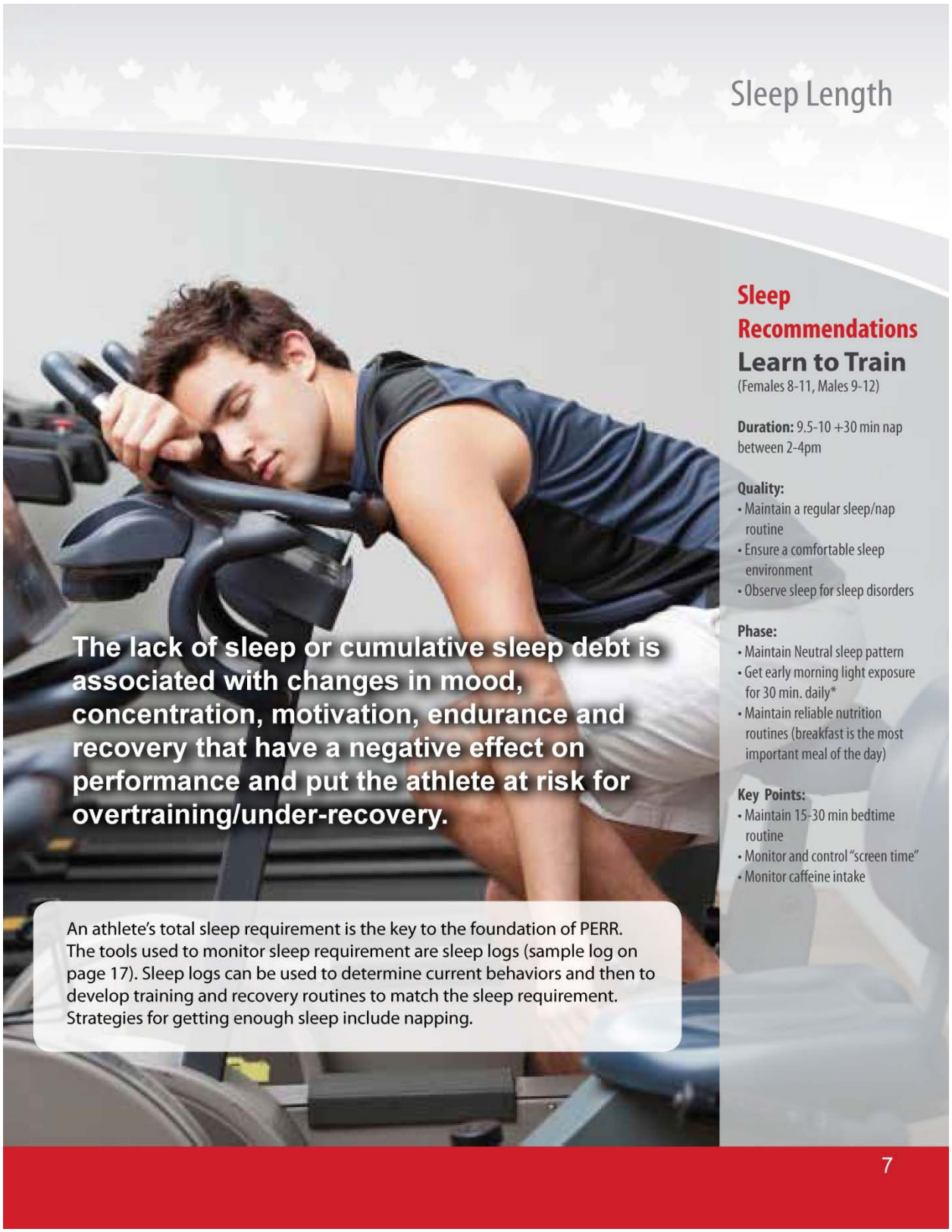
Figure 2. **Sleep staging variations and changes** throughout the life span. Sleep latency – time to fall asleep, WASO – wake after sleep onset, REM – Dream Sleep, SWS – Slow Wave (Deep) Sleep, Stage 1 and 2 – Light Sleep. Adapted from Ohayon et al.[4]



From a Canadian perspective, a sample of 272 National and Olympic Team athletes and coaches ranging from 15 to 57 years old were screened during the 2009 annual medical review. The results revealed a range of 4.5 to 10.5 hours of sleep per night with an average of 7.8 hours of sleep per night in these athletes.

A recent study of intercollegiate athletes by Mah (2011) at Stanford University found that increasing the nightly sleep period of 18-20 year old varsity basketball players to at least 10 hours, for a duration of 5-7 weeks led to faster sprint times, increased accuracy, and improved overall ratings of physical and mental well-being during practices and games.[2] These results demonstrate a discrepancy between athletes' behaviours (how much sleep they get) and athletes' sleep requirements (how much sleep they need).

Therefore, it is important to establish sleep routines at the Active Start stage, maintain those routines insuring adequate sleep through the FUNdamental and Learn to Train stages (6 – 12 years old) and prepare for the challenges of getting adequate sleep (9 – 10 hours per night) during the Train to Train and Train to Compete stages (adolescence). This "upfront effort" will establish the importance of sleep and sleep routines for the demanding Train to Win stage so the added stress of travel can be more easily managed to reduce the impact of travel fatigue and jet lag.



Sleep Length

Naps should also be a part of the routine and follow simple rules.

1) Naps should be limited to 30 minutes.
2) Naps should be scheduled in the mid to late afternoon (2 – 4pm) but not after 4pm so it does not affect the athletes ability to fall asleep at bedtime.
3) Naps can be combined with a dose of caffeine, for the older athletes (cup of coffee either before or immediately after the nap).

The combination of caffeine and napping has been shown to improve the restorative quality of the nap and post-nap alertness/concentration. It is paramount that the athlete determines the amount of sleep needed per week (e.g., 8 hours per day = 56 hours per week). This gives the athlete a sense of how much sleep they require and how much sleep debt they accumulate per week. With this information the athlete and support staff can develop sleep and napping strategies which will then dictate training routines with the ultimate goal of reducing cumulative sleep debt.

8

Sleep Quality

Sleep quality refers to the restorative quality of the sleep state/period and is subjectively assessed and reported by the athlete. The key point here is that an athlete may be getting "enough sleep" (hours/night) but the quality of the sleep could be poor and non-restorative. Typical factors that affect sleep quality are sleep disorders, environmental disturbance, and mood disorders. Normal sleepers usually fall asleep within 20-30 minutes of turning off the light and can sleep through the night with brief awakenings and wake spontaneously in the morning without an alarm feeling refreshed within an hour of waking up.

Sleep disorders are common and treatable, but often remain undiagnosed and untreated especially in children. Unrecognized sleep disorders affect personal health and may lead to chronic sleep loss which, in turn, can increase the risk of poor performance and injuries.

The most common sleep disorders that can affect athletic performance are insomnia, obstructive sleep apnea, movement disorders in sleep, and parasomnias. A sleep disorder in an athlete will compound the disturbance in sleep quality for the older athletes due to the chronic sleep disturbance and sleep loss resulting from rigorous training and competition schedules.

Sleep Recommendations

Train to Train

(Females 11-15, Males 12-16)

Duration: 9 +30 min nap between 2-4pm

Quality:
- Ensure a comfortable sleep environment
- Initiate regular napping strategy
- Monitor for excessive sleepiness & fatigue
- Observe sleep for sleep disorders

Phase:
- Maintain a regular sleep/nap routine
- Get early morning light exposure for 30 min daily*
- Monitor for a delayed sleep phase (difficulty falling asleep and waking up for school)
- Maintain reliable nutrition routines (breakfast is the most important meal of the day)

Key Points:
- Reinforce the importance of sleep routine
- Monitor for cumulative sleep debt (<9 hours/night or <56 hours/week)
- Monitor caffeine intake
- Do not train on an unrested body


Insomnia is defined as the subjective complaint of difficulty falling asleep, difficulty staying asleep, and early morning awakening with difficulty finishing the sleep period.
INSOMNIA
Insomnia can occur acutely and resolve quickly or can be triggered by an acute event (travel, stress, injury) and become a chronic problem. By definition acute insomnia lasts less than four to six weeks. In the athlete population common causes of acute insomnia include increased training loads, competition stress, illness, injury, travel or sleep environment, and medications. Chronic insomnia by definition lasts longer than four to six weeks and can be prevented by early detection and treatment. Chronic insomnia is common in those athletes who are predisposed to difficulty with sleep as infants and children; therefore, it is predictable and can be monitored by the athlete, parents or coach. Chronic sleep disturbance due to insomnia does pose a risk for the development of mood disorders such as depression and anxiety and can certainly affect the athlete's ability to recover and cope with the stresses of training and competition. The consequences of insomnia include poor concentration, memory loss, irritability, low mood and excessive anxiety. This can obviously impair an athlete's ability to train (reduced motivation), recover (disturbed sleep) and perform (poor concentration, balance, endurance and strength).
10

Sleep Quality

Obstructive sleep apnea (OSA) is a disorder associated with snoring and repeated interruption of breathing during sleep caused by obstruction of the upper airway.

OBSTRUCTIVE SLEEP APNEA

The obstruction occurs when the tongue relaxes during sleep and blocks the airway resulting in a pause in breathing, reduced oxygen levels and repeated arousal through the night. The obstructions in breathing occur repeatedly through the night, are usually not recognized by the individual and cause substantial disturbance to the sleep state. The most obvious symptoms of OSA include frequent cessation of breathing (apnea) during sleep that are observed by bed partners, loud and disruptive snoring, and choking or gasping during sleep. While OSA is rare in young healthy individuals, snoring is not. Those athletes who do snore (at any age) and do complain of non-restorative/restless sleep or daytime fatigue should be assessed for OSA because it is easily detected and treated. Obstructive sleep apnea that is left untreated in an athlete can seriously affect an athlete's ability to train, recover and perform.

Sleep Recommendations

Train to Compete

(Females 15-21+/-, Males 16-23+/-)

Duration: 8 -10 +30 min nap between 2-4pm

Quality:
- Ensure a comfortable sleep environment when travelling and competing
- Monitor for competition stress & anxiety → insomnia
- Monitor for excessive sleepiness & fatigue
- Observe sleep for sleep disorders

Phase:
- Maintain regular sleep/nap routine
- Monitor for a delayed sleep phase (difficulty falling asleep and waking up for school)
- Get early morning light exposure for 30 min. daily
- Maintain reliable nutrition routines (breakfast is the most important meal of the day)

Key Points:
- Focus on reducing sleep debt. Get 56-70 hours of sleep/week
- Do not train if unrested and sleep deprived
- Avoid technology (screen time) before bed
- If your sleep is poor seek help

Movement disorders such as restless legs syndrome (RLS), periodic limb movements in sleep (rhythmic leg/arm kicking) and sleep bruxism (tooth grinding) are defined as sleep related movements that cause significant sleep disturbance.

MOVEMENT DISORDERS

Restless leg syndrome is characterized by a disturbing sensation in the legs and an irresistible need to move the legs that occurs when sitting quietly or in bed before falling asleep. Periodic limb movement disorder occurs during sleep and is characterized by rhythmic leg kicking and very restless sleep. Sleep bruxism or tooth grinding is characterized by audible grinding of the teeth during sleep and/or jaw tension causing sleep disruption and jaw and facial pain. These conditions occur in the athlete population and do disrupt the restorative quality of the sleep state. Restless leg syndrome is hereditary (common within families) and occurs in individuals with low serum iron levels (common in female athletes). Periodic limb movement disorder is common in certain athlete populations such as swimmers. Sleep bruxism is common in those individuals who are anxious and stressed. Therefore, athletes who complain of non-restorative sleep or the symptoms of a movement disorder should see their doctor and get properly assessed and treated to preserve the integrity of the sleep state and PERR process.

PARASOMNIAS

Parasomnias (e.g., bedwetting, sleep walking, night terrors, and sleep eating) are unpleasant or undesirable behaviors that occur during sleep. Generally speaking, parasomnias are more common in childhood and tend to resolve during adolescence. While parasomnias tend not to be overly disturbing to the individual, they are disturbing to parents and bed partners. The fact is that if a parasomnia is present it can disturb the sleep state and PERR process. More importantly, the common triggers for parasomnias are emotional stress, sleep deprivation and medications that cause sedation or stimulation. Again, the important point here is that if these behaviors occur in an athlete and certainly if they occur while travelling the athlete should be assessed by their doctor and possibly referred to a sleep clinic for assessment.

Sleep Quality

ENVIRONMENTAL SLEEP DISTURBANCE

Environmental sleep disturbance is probably the most important and common modifiable factor affecting an athlete's sleep quality. Environmental sleep disturbance occurs when conditions in the surrounding sleep environment disturb the athlete's sleep. This can be caused by noise (bed partner snoring or noise from outside), bed motion (restless bed partner), light (through a window), temperature (being too hot or too cold), and most importantly from the athletes exposure to technology (computer screens and smart phones) prior to sleep and during the sleep period. The sleep environment must be a sanctuary devoted to sleep and the room should be conducive to sleep. This means the athlete's pre-sleep routine should include a 1-2 hour downtime prior to bedtime that includes low light exposure, relaxing activities (no computer or video games and no excessive use of the smart phone). The bedroom should be quiet, pitch dark (light disturbs the sleep quality) and comfortable temperature and humidity. If noise and light are an issue the athlete should use earplugs and eyeshades for sleep (especially when travelling). The bed and mattress should be comfortable.

The sleeping environment should be respected by others to ensure that this area can be readily available for sleep. The sleep environment becomes more important and less stable when the athletes are travelling so it is important for the athlete to have a routine for managing sleep disturbance when travelling. Most importantly, the coaches need to attend to preferences if possible when the athletes are travelling, sharing rooms and sleeping in suboptimal environments.

Sleep Recommendations

Train to Win

(Females 18+, Males 19+)

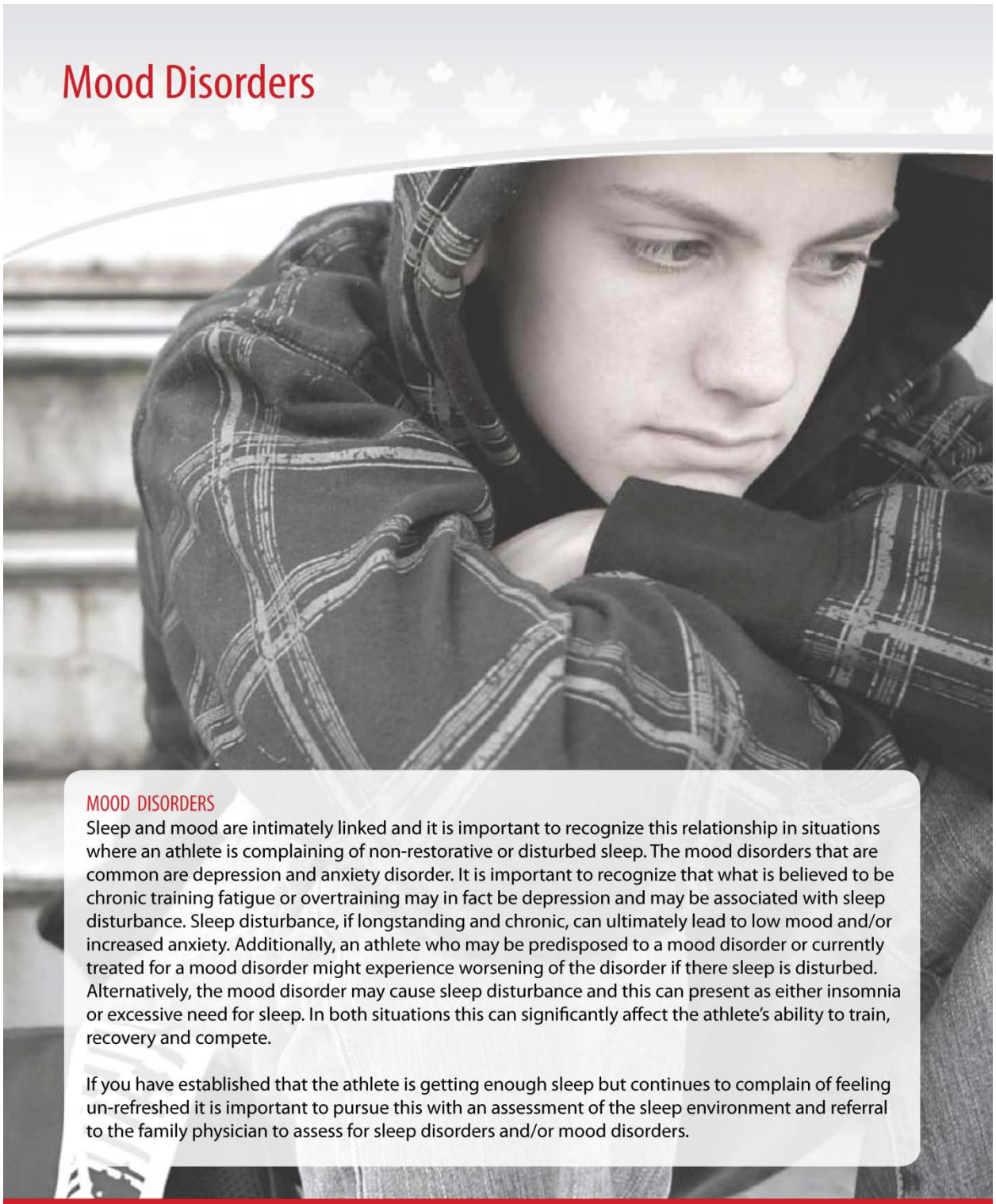
Duration: 8-10 hrs +30 min nap between 2-4pm

Quality:
- Ensure a comfortable sleep environment when travelling and competing
- Monitor for competition stress & anxiety →insomnia
- Observe sleep for sleep disorders

Phase:
- Maintain regular sleep/nap routine
- Monitor for a delayed sleep phase (difficulty falling asleep and waking up for school)
- Get early morning light exposure for 30 min daily*
- Maintain reliable nutrition routines (breakfast is the most important meal of the day)

Key Points:
- Focus on reducing sleep debt. Get 56–70 hours of sleep/week
- Do not train if unrested and sleep deprived
- Avoid technology (screen time) before bed
- If your sleep is poor get help

Mood Disorders



MOOD DISORDERS

Sleep and mood are intimately linked and it is important to recognize this relationship in situations where an athlete is complaining of non-restorative or disturbed sleep. The mood disorders that are common are depression and anxiety disorder. It is important to recognize that what is believed to be chronic training fatigue or overtraining may in fact be depression and may be associated with sleep disturbance. Sleep disturbance, if longstanding and chronic, can ultimately lead to low mood and/or increased anxiety. Additionally, an athlete who may be predisposed to a mood disorder or currently treated for a mood disorder might experience worsening of the disorder if there sleep is disturbed. Alternatively, the mood disorder may cause sleep disturbance and this can present as either insomnia or excessive need for sleep. In both situations this can significantly affect the athlete's ability to train, recovery and compete.

If you have established that the athlete is getting enough sleep but continues to complain of feeling un-refreshed it is important to pursue this with an assessment of the sleep environment and referral to the family physician to assess for sleep disorders and/or mood disorders.

Sleep Phase

CIRCADIAN SYSTEM

The circadian timing of sleep directly affects sleep length and sleep quality. Additionally, the circadian system regulates the feeling of sleepiness and wakefulness throughout the day which directly affects athletic performance. Generally speaking, upon awakening in the morning we feel alert until after lunch when most people become sleepy (the afternoon siesta time) for 30-60 minutes and then we are alert again with a peak in the evening around 6-8PM. Finally, as bedtime draws near, we become sleepy again and this facilitates the onset of sleep at bedtime. The circadian phase is genetically and environmentally determined. Each athlete has a preferred sleep schedule that suits his or her circadian phase; however, training, school, and work commitments can have a substantial impact on the athlete's ability to match their circadian phase to the available time for sleep. If the circadian phase and sleep schedule are not matched (out of phase) the amount of sleep that can be achieved, as well as the quality of that sleep will be affected. For example, adolescents have a natural tendency to become night owls, delaying bedtime. The delay in sleep onset (midnight to 1AM) in combination with having to get up for school (7–8am) and the fact that adolescents need 9-10 hours of sleep per day results in a chronic sleep debt that affects daytime performance, alters mood, increases appetite and impairs PERR. The circadian sleep phases can be managed and stabilized by establishing sleep routines as described in Table 1.

During adulthood, total sleep time tends to stay relatively stable and the amount of REM sleep tends to be maintained while the amount of SWS decreases and sleep progressively becomes lighter (more stage 1 and 2) and more disturbed (Figure 3). The three parameters of sleep discussed above (total sleep time, sleep disturbance, and circadian phase) are key factors that have dramatic impact on an athlete's potential to train, recover, and perform to an optimal level during competition, and as such, should form the basic foundation of every athlete's training regime.

Sleep Recommendations

Active for Life

(Any age participant)

Duration: 7-9 +30 min nap between 2-4pm

Quality:

- Maintain a regular sleep/nap routine keep your sleep debt to a minimum
- Ensure a comfortable sleep environment
- If your sleep is poor quality seek help!

Phase:

- Maintain a regular sleep schedule
- Get early morning light exposure for 30 min daily
- Maintain reliable nutrition routines (breakfast is the most important meal of the day)

Key Points:

- Get your sleep!
- Maintain meal routines and always eat breakfast
- Learn to nap
- Do not train if you are fatigued or sleep deprived

Final Comments

Sleep is the foundation of PERR. For the most part we have a tendency to ignore sleep or compromise sleep for other activities and not consider sleep a priority. Athletes have no choice but to make sleep a priority because their competitors do, and it could be the difference between winning and losing or experiencing a career ending injury. Parents, coaches and trainers have to help the athlete develop and maintain good sleep habits and routines during the off-season, pre-season and competitive season throughout the athlete's career. These routines have to take into account changing demands through the developmental stages such as sleep requirements, training volume/intensity and travel. The most important messages to remember and pass on to others are sleep requirements and potential disturbances change over time, establishing a sleep routine is the key, never compromise sleep for training, establish the importance of sleep early in the athletes career, provide time for sleep opportunity, and if the athlete complains of poor sleep get help.

16

Sleep and the Lifecycle of an Athlete

LTAD Stage Specific Sleep Recommendations	Sleep Recommendations			
	Duration (hrs/night)	Quality	Phase	Key Points
Active Start (Females & M ales 0-6 years)	13-16	• Establish and maintain a sleep/nap routine • Ensure a comfortable/safe sleep environment • Avoid stimulation 1-2 hrs before bed; minimize "screen time"	• Consolidate nighttime sleep period • Decrease naps to 1-2/day in the first year • Natural light exposure first thing in the morning	• Establish stable sleep routines and a bedtime routine • Use a sleep transition object • Introduce independent sleep initiating behaviors
FUNdamentals (Females 6-8, Males 6-9)	10-11 + 30 min nap between 2-4pm	• Maintain a regular sleep/nap routine • Ensure a comfortable sleep environment • Establish independent sleep initiating behaviors • Observe sleep for sleep disorders	• Establish a neutral sleep pattern between 9pm and 8am • Encourage predictable afternoon nap/ rest • Establish reliable meal routines (breakfast is the most important meal of the day)	• Reinforce 15-30 min bedtime routine • Avoid stimulation 1-2 hours before bed, control "screen time" • Good nutrition and meal routines reinforce sleep routines
Learn to Train (Females 8-11, Males 9-12)	9.5-10 + 30 min nap between 2-4pm	• Maintain a regular sleep/nap routine • Ensure a comfortable sleep environment • Observe sleep for sleep disorders	• Maintain Neutral sleep pattern • Get early morning light exposure for 30 min. daily* • Maintain reliable nutrition routines (breakfast is the most important meal of the day)	• Maintain 15-30 min. bedtime routine • Monitor and control "screen time" • Monitor caffeine intake
Train to Train (Females 11-15, Males 12-16)	9 + 30 min nap between 2-4pm	• Ensure a comfortable sleep environment • Initiate regular napping strategy • Monitor for excessive sleepiness and fatigue • Observe sleep for sleep disorders	• Maintain a regular sleep/nap routine • Get early morning light exposure for 30 min. daily* • Monitor for a delayed sleep phase (difficulty falling asleep and waking up for school) • Maintain reliable nutrition routines (breakfast is the most important meal of the day)	• Reinforce the importance of sleep routine • Monitor for cumulative sleep debt (<9 hours/night or <56 hours/week) • Monitor caffeine intake • Do not train on an unrested body
Train to Compete (Females 15-21 +/-, Males 16-23 +/-)	8 -10 + 30 min nap between 2-4pm	• Ensure a comfortable sleep environment when travelling and competing • Monitor for competition stress and anxiety →insomnia • Monitor for excessive sleepiness and fatigue • Observe sleep for sleep disorders	• Maintain regular sleep/nap routine • Monitor for a delayed sleep phase (difficulty falling asleep and waking up for school) • Get early morning light exposure for 30 min. daily • Maintain reliable nutrition routines (breakfast is the most important meal of the day)	• Focus on reducing sleep debt. Get 56-70 hours of sleep/week • Do not train if unrested and sleep deprived • Avoid technology (screen time) before bed • If your sleep is poor seek help
Train to Win (Females 18+, Males 19+)	8-10 hrs + 30 min nap between 2-4pm	• Ensure a comfortable sleep environment when travelling and competing • Monitor for competition Stress & anxiety → insomnia • Observe sleep for sleep disorders	• Maintain regular sleep/nap routine • Monitor for a delayed sleep phase (difficulty falling asleep and waking up for school) • Get early morning light exposure for 30 min. daily* • Maintain reliable nutrition routines (breakfast is the most important meal of the day)	• Focus on reducing sleep debt. Get 56-70 hours of sleep/week • Do not train if unrested and sleep deprived • Avoid technology (screen time) before bed • If your sleep is poor get help
Active for Life (Any age participant)	7-9 + 30 min nap between 2-4pm	• Maintain a regular sleep/nap routine keep your sleep debt to a minimum • Ensure a comfortable sleep environment • If your sleep is poor quality seek help!	• Maintain a regular sleep schedule • Get early morning light exposure for 30 min daily • Maintain reliable nutrition routines (breakfast is the most important meal of the day)	• Get your sleep! • Maintain meal routines and always eat breakfast • Learn to nap • Do not train if you are fatigued or sleep deprived

*see: http://www.litebook.ca/

Table 1. Stage specific recommendations for the critical determinants of sleep and associated key points. Adapted from Weiss.[5]

17

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*EXAMPLE for completing sleep logs

SLEEP LOGS

(1) With a black marker, fill in time slept. (2) Fill in all nap times during the day. (3) Rate your sleep.

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Mon Jul 7																								

0 (very poor) – 10 (very good) sleep was rated 7 0 (exhausted) – 10 (refreshed), this morning I felt 6

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Tues Jul 8																								

0 (very poor) – 10 (very good) sleep was rated 4 0 (exhausted) – 10 (refreshed), this morning I felt 3

Patient Name: ______________________ Week Beginning: ______________________

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 10 (refreshed), this morning I felt _____

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 10 (refreshed), this morning I felt _____

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 100 (refreshed), this morning I felt _____

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 10 (refreshed), this morning I felt _____

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 10 (refreshed), this morning I felt _____

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 10 (refreshed), this morning I felt _____

	PM 6	7	8	9	10	11	12	1	2	3	4	5	AM 6	7	8	9	10	11	12	1	2	3	4	5
Date																								

0 (very poor) – 10 (very good) sleep was rated _____ 0 (exhausted) – 10 (refreshed), this morning I felt _____

18

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SELECTED READINGS

- "Say Good Night to Insomnia: the 6-week solution" by G.S. Jacobs.
  This book is an excellent resource for athletes who struggle with insomnia.

- "Take a Nap! Change Your Life." by S.C. Mednick.
  This book is recommended reading for athletes, coaches and trainers and gives excellent advice about napping routines.

- "Better Sleep for Your Baby and Child: A Parent's Step-by-Step Guide to Healthy Sleep Habits" by S.K. Weiss.
  This book is a must read for parents and gives excellent advice for establishing good sleep routines for babies, children and teenagers.

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Other Canadian Sport for Life Resources

canadiansportforlife.ca/resources/ltad-resource-papers

Canadian Sport for Life Resource Paper
A Sport Parent's Guide
Developing Physical Literacy
No Accidental Champions

The Role of Monitoring Growth in Long-Term Athlete Development
Competition is a Good Servant, but a Poor Master
Linking Sport for Life with Management by Values
Maximizing the Sport Experience for our Children
Recovery and Regeneration for Long-Term Athlete Development
The Female Athlete Perspective

We acknowledge the financial support of the
Government of Canada through Sport Canada,
a branch of the Department of Canadian Heritage.

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Source: C. H. Samuels and B. N. Alexander. *Sleep, Recovery, and Human Performance*. Available at http://canadiansportforlife.ca/sites/default/files/resources/Sleep_Recovery_Jan2013_EN_web.pdf.

PREVENTION ACTION PLANS

Two kinds of Prevention Action Plans play key roles in prevention of and recovery from injury. One is the Annual Prevention Action Plan, and the other is the Daily and Weekly Prevention Action Plan. Taken together, these two plans specify strategies to follow to prevent injury and recover from hard training.

The Annual Prevention Action Plan deals with prevention and recovery strategies that vary from one training phase to another, i.e., are periodized.

The Daily and Weekly Prevention Action Plan deals with prevention and recovery strategies that are used on a daily or weekly basis.

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