6.3 Cold as a Risk Factor

The Challenge of Exercising in the Cold

- ❏ The colder the environment, the faster a participant's body temperature will decrease.
- ❏ During exercise in a cold environment, the skin can become wet as a result of sweating or exposure to rain or snow. A wet skin surface cools the body faster than a dry skin surface.
- ❏ The temperature may drop considerably once the sun has set, which can quickly increase the level of risk associated with exercising in a cold environment.
- ❏ The wind magnifies the perception of cold, and increases the rate at which the body loses heat. This effect can be further amplified if the skin is wet.
- ❏ In cold weather, high humidity makes the temperature feel colder than the air temperature indicates it is.
- ❏ It is generally easier to tolerate cold when the air is dry although cold, dry air makes it difficult for some asthmatics to breathe.
- ❏ Skin can freeze when exposed to very cold temperatures, and when this happens circulation slows. Tissue can be damaged if frostbite is prolonged and extensive. Extremities (e.g. toes, fingers, nose, ears) are particularly at risk in cold temperatures, because the body shunts blood flow to central organs and tissues to maintain the body's core temperature.
- ❏ In severe cold, brain function can slow down, and so risk of further injury increases with prolonged exposure.
- ❏ Children get cold much faster than adults, and their skin is more prone to freeze. People with less body fat usually have less tolerance for cold than those with more body fat.
- ❏ Muscles and other soft tissues that are cold are more susceptible to injuries such as pulls and tears, especially if movements are sudden and intense.
- ❏ In very dry cold environments, water vapour lost through breathing and the evaporation of sweat from exposed surfaces may lead to dehydration.
- ❏ It can be a challenge to wear appropriate clothing for exercising in the cold. On the one hand clothes must protect the skier against the cold; on the other hand they must not impair the body's ability to get rid of the heat produced during exercise. Heavy clothing can be cumbersome and interfere with movement, and it can also increase air resistance in some sports where speed is critical. At the same time, the thin clothing used in many sports frequently offers little protection from the cold and the wind. Refer to "Clothing for Cross-Country Skiing Activities" and "Lesson Plan - Dressing Appropriately for Skiing" (sections 3.1 and 3.2) for more information.
- ❏ The type of fabric worn can either wick water from the body surface (i.e. synthetics such as polypropylene or Gore-Tex ®) which results in less risk of heat loss, or trap it there (i.e. cotton or nylon) which results in greater risk of heat loss.

Steps to Avoid Cold Injuries

When exercising in the cold:

- ❏ Ensure participants wear sufficient clothing for the conditions, and layer clothing as follows:
  - ✓ Layer closest to skin: polypropylene, close fitting (wicking effect).
  - ✓ Second layer: fleece or wool, slight room between first layer and second layer for "trapped air" effect.
  - ✓ Third layer: wind-breaking, water repellent, breathable layer.
- ❏ When it is very cold, ensure exposed surfaces are kept to a minimum.
- ❏ Once the body has warmed up, and if the temperature is not too cold, consider removal of the second layer of clothes during exercise to avoid excessive sweating. Have participants add a layer or use blankets to keep warm during breaks or pauses.
- ❏ Apply anti-perspirant to feet before exercising to lessen sweating of the feet (which is usually followed by cooling of the feet). Doing the same on the palm of the hands may reduce the feeling of cold for people who tend to sweat a lot in their gloves or mitts.
- ❏ Ensure participants hydrate when they exercise in the cold.
- ❏ Bring children inside when they say they are cold. It is not worth the risk to prolong exercise and have them suffer from frostbite. Once a person suffers serious frostbite, the risk of subsequent frostbites to the same area may be increased.
- ❏ Never send skiers out into the cold alone or without means of communicating with you and/or an emergency centre. Avoid prolonged activities in which participants are in isolated areas and run the risk of becoming exhausted.
- ❏ When the weather is very cold, and your group needs to train on snow, hold your practices between 11 a.m. and 2 p.m. as these tend to be the warmest hours of the day. Be aware that temperature drops quickly when the sun sets.
- ❏ Educate the skiers and their parents to consider the combined effect of cold and wind when making decisions about how to dress for an outdoor session, rather than simply looking at the thermometer. Do the same when you make coaching decisions about the choice and the scheduling of activities.
- ❏ If possible, choose areas that are protected from the wind and avoid activities in open areas.
- ❏ Ensure protective eyewear is worn to prevent snow reflection from damaging eyes, and to protect them from the cold and the wind.
- ❏ Have the skiers or their parents bring a change of clothing, especially socks and underwear. Try to find a warm and protected spot to change. It is especially important to change after exercising, rather than to stay in damp clothing for the drive home.
- ❏ Inform skiers and parents that a hat should be warn at all times; over 30% of body heat may be lost through the head. Ensure ears are covered to avoid frostbite.
- ❏ Allow additional time to warm up for a training session or a competition. It takes longer to get the body warmed up and ready for a sport activity in cold weather than it does in warm weather.

Wind Chill Factor

Wind makes cold temperatures feel colder. The “wind chill factor” is an index that combines air temperature and wind velocity, and measures the rate at which living creatures lose body heat to the environment. It is not a temperature in the strict sense, but a temperature-like number that quantifies the sensation of cold. It was created to help reduce the risk of frostbite and other cold-related injuries. The wind chill factor should be consulted prior to exercising in the cold, as it provides more useful information regarding the best way to dress than temperature alone.

The table below shows the equivalent temperature (C) felt by the human body as a result of the combined effects of ambient temperature and wind velocity.

Wind Chill Calculation Chart

T air = Air temperature in °C and V10 = Observed wind speed at 10m elevation, in km/h.

T air	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
V_{10}												
5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	**-58**
10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	**-57**	**-63**
15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	**-60**	**-66**
20	1	-5	-12	-18	-24	-30	-37	-43	-49	**-56**	**-62**	**-68**
25	1	-6	-12	-19	-25	-32	-38	-44	-51	**-57**	**-64**	**-70**
30	0	-6	-13	-20	-26	-33	-39	-46	-52	**-59**	**-65**	**-72**
35	0	-7	-14	-20	-27	-33	-40	-47	-53	**-60**	**-66**	**-73**
40	-1	-7	-14	-21	-27	-34	-41	-48	-54	**-61**	**-68**	**-74**
45	-1	-8	-15	-21	-28	-35	-42	-48	**-55**	**-62**	**-69**	**-75**
50	-1	-8	-15	-22	-29	-35	-42	-49	**-56**	**-63**	**-69**	**-76**
55	-2	-8	-15	-22	-29	-36	-43	-50	**-57**	**-63**	**-70**	**-77**
60	-2	-9	-16	-23	-30	-36	-43	-50	**-57**	**-64**	**-71**	**-78**
65	-2	-9	-16	-23	-30	-37	-44	-51	**-58**	**-65**	**-72**	**-79**
70	-2	-9	-16	-23	-30	-37	-44	-51	**-58**	**-65**	**-72**	**-80**
75	-3	-10	-17	-24	-31	-38	-45	-52	**-59**	**-66**	**-73**	**-80**
80	-3	-10	-17	-24	-31	-38	-45	-52	**-60**	**-67**	**-74**	**-81**

FROSTBITE GUIDE
Low risk of frostbite for most people
Increasing risk of frostbite for most people in ten to 30 minutes of exposure
High risk for most people in five to ten minutes of exposure
High risk for most people in two to five minutes of exposure
High risk for most people in two minutes of exposure or less

Wind Chill - Minutes to Frostbite

The following are approximate values:

Temperature (°C)	-15	-20	-25	-30	-35	-40	-45	-50
Wind (km/h)								
10	•	•	22	15	10	8	7	**2**
20	•	30	14	10	5	4	**3**	**2**
30	•	18	11	8	5	**2**	**2**	**1**
40	42	14	9	5	**5**	**2**	**2**	**1**
50	27	12	8	**5**	**2**	**2**	**2**	**1**
60	22	10	7	**5**	**2**	**2**	**2**	**1**
70	18	9	5	**4**	**2**	**2**	**2**	**1**
80	16	8	**5**	**4**	**2**	**2**	**2**	**1**

• = Frostbite unlikely

The wind speed, in km/h, is at the standard anemometer height of ten metres (as reported in weather observations).

Frostbite possible in two minutes or less
Frostbite possible in three to five minutes
Frostbite possible in six to ten minutes

6.4 Trail Safety

Section 6.1, *Sport Safety Through Risk Management,* reviews possible safety concerns that a coach should keep in mind before and during an activity session. Where possible the trails the group will ski on should be pre-skied to ensure there are no dangerous situations present. For example icy conditions significantly change the difficulty of a trail, and “blind corners” should be approached with care. Also remember to ensure that no trail grooming machinery will be present on the trails you will be using.

- ❏ Know which trails you are allowed to ski on, and never ski outside the designated area.
- ❏ If you plan to ski in unfamiliar areas, carry a map and stay on recognized trails. Advise others of intended routes and plans.
- ❏ Leave a safe trail: fill in holes that you make; remove obstructions; mark hazards on the trail; and advise authorities of problems.
- ❏ Avoid skiing in darkness without a head lamp.

The following **“My Trail Etiquette Promise”** is a useful 12-point summary on trail etiquette to present to your skiers.

1) If I practice good trail etiquette it will make skiing more fun for everyone!
2) When I overtake slower skiers I can call out “track” or I can move to the left and go around them.
3) When faster skiers come up behind me I will move to the right and let them pass.
4) If I meet another skier head on I will pass to the right.
5) If a trail is too narrow for two skiers to pass, I will move to the side and wait until the other skier passes.
6) I will remember that skiers coming down a hill have the right of way.
7) If I need to stop, or if I fall, I will move off the trail to allow clear passage for other skiers.
8) I will move off the trail if I want to visit with my ski-friends.
9) I will not take my pets on a ski trail unless the trail has been designated for use by pets (i.e. K-9 Trail).
10) I will not litter and I will pack out what I packed in.
11) I will respect the custom and say a friendly “hello” when passing other skiers.
12) I will obey the trail signs and ski in designated areas only.

6.5 Winter Safety

The following sections in this Reference Material, *"Cold as a Risk Factor", "Hypothermia", and "Clothing for Cross Country Skiing Activities"* (sections 6.3, 6.6 and 3.1), highlight many of the important environment related risk factors that you should keep in mind during your coaching activities. The following summary of tips should be reviewed with your skiers during one of your sessions.

- ❏ Never ski alone.
- ❏ Dress appropriately for ski sessions, so as to stay dry and warm. Be prepared for bad weather or changing conditions.
- ❏ Be prepared for accidents, emergencies or damaged equipment. Bring a backpack on longer trips, with first aid kit, space blanket, drinks and equipment repair materials.
- ❏ Learn what to do if you become lost.
- ❏ Find out what hypothermia and dehydration are, the signs and symptoms to watch out for, and what you should do if a problem occurs.
- ❏ Re-evaluate your plans if you or a group member starts to fatigue.
- ❏ Do not ski out of control.
- ❏ Ski terrain and distances suited to the fitness levels and abilities of your group members. Occasionally evaluate everyone's condition.
- ❏ Be aware of the dangers of crossing bodies of water in winter. Proceed one person at a time and check the thickness of the ice with your poles.
- ❏ Do not ski in avalanche areas without proper training and equipment.

Frostbite

The chances of frostbite and hypothermia are forever present and skiers should be aware of that fact and act accordingly.

- ❏ The body's extremities (fingers, toes and ears) are common places for frostbite.
- ❏ As your body gets cold it shuts off the blood supply to the extremities and they freeze.
- ❏ Cold temperature combined with constrictive clothing or boots greatly contributes to frostbite.
- ❏ Parts exposed to wind and wet readily become frostbitten.
- ❏ Symptoms of frostbite are white and waxy skin, with feeling lost in the affected area.
- ❏ Frostbitten parts (white) should be warmed up quickly by cupping with the hands or bathing in warm water.

- ❏ Do not rub the frostbitten area, especially with snow.
- ❏ You may not notice frostbite on yourself, so watch out for each other on cold days.
- ❏ Watch the other skiers in your group for signs of frostbite.

Coaching Tip: The essence of safety is knowing what to do to avoid trouble and how to handle it should it occur.

6.6 Hypothermia

Cold! The thought raises markedly different images in different athlete's minds. For some it prompts an avoidance reaction that has them gravitating towards the fireplace or migrating south towards sunnier climes. For others, it represents a challenge that is an integral part of their chosen sport. Winter weather and cold temperatures do pose one very real danger for everyone involved in activities outdoors: hypothermia!

Hypothermia, however, is not restricted to one season to the exclusion of all others. Sub-zero temperatures are not the only contributing factor for the onset of the condition. Any situation that results in the body expending more heat than it creates for a prolonged period of time increases the risk of hypothermia. For athletes who are naturally low in body fat and are involved in outdoor sports with high energy and fluid expenditures, the risk factors are even greater.

Definition

The normal body temperature is around 37° C. Hypothermia occurs when body temperature falls below 35° C and the body's heat loss exceeds its heat production. At this temperature the body no longer generates enough heat to maintain body functions. The heat loss can happen in four different ways: by radiation, evaporation, conduction, and/or convection. Of these, radiation is the main source (60%) of heat loss from the body. Basically, if the environmental temperature is cooler than that of the body, heat travels outward.

Basic Physiology

An area in the brain called the hypothalamus acts as the body's thermostat. It is the central controller of heat balance in the body and triggers an increase in the rate of heat production when the body temperature falls. It is the hypothalamus that makes us shiver when we are cold. Shivering, an involuntary muscle contraction, is the main mechanism for producing heat by increasing our metabolic rate. This can increase the body's heat production by up to five times. The hypothalamus is also responsible for decreasing the blood supply to peripheral areas of the body in order to maintain core temperature and increase hormone production to "up" the metabolic rate. It is when these survival mechanisms fail, and the body is unable to maintain its core temperature, that hypothermia develops. The signs and symptoms are progressive according to the amount of heat loss from the body. An individual's condition deteriorates as the body temperature drops. (See Stages of Hypothermia Table)

A Danger for All Seasons

Although hypothermia is usually associated with harsh winter conditions, it would be wrong to assume that this is the only time of year that someone involved in outdoor activities is at risk. Walkers and hikers who are ill-prepared for the vagaries of weather that can occur in the mountains are particularly susceptible. Wet clothing and the chilling effect of strong winds promote increased body heat loss. Swimmers, divers, triathletes or anyone taking part in aquatic sports have to be aware that water has a much higher thermal conductivity than air and, accordingly, heat is lost from the body more rapidly during cold water immersion than during exposure to air of the same temperature. In winter, cross-country skiers are more at risk than

their downhill counterparts. This is because exhaustion and dehydration are both strong influencing components for the onset of the early stages of hypothermia. *It should also be noted that the whole process from mild exposure to severe hypothermia may take only a few hours or less.*

Risk Factors

A variety of other conditions can also do their part in contributing to the increased chance of succumbing to hypothermia. Drug or alcohol use, hunger, anemia, impaired circulation are all flags for danger when allied to some of the other factors already outlined. Certain medical conditions such as diabetes mellitus and thyroid disorders which adversely affect the body's ability to regulate its own temperature should also be taken into consideration. *Moreover, children and the elderly are more at risk as they are less able to retain body heat in cold conditions.*

Treating Hypothermia

The longer the body core loses heat, the more difficult it is to re-warm. It is therefore imperative to treat hypothermia at the earliest possible stage. The first step of a "cure" is to get the victim out of the cold, wind and rain (or water) and into shelter. If the person is at the shivering stage but not exhibiting other more serious symptoms, get him or her into dry clothing and give them a hot, non-alcoholic drink with some high energy food. It is important to remember that body cooling may increase when the hypothermia victim stops exercising because the extra heat generated by activity then ceases. Someone who was only shivering mildly may begin to show more serious signs upon entering a warm environment.

A person who has slipped further into hypothermia syndrome than the stage of moderate shivering needs more help. Putting the victim into a sleeping bag with another person is a very effective method of re-warming. Skin to skin contact especially in the neck and chest is most beneficial. If available, warm baths are also an effective way to re-warm the moderately hypothermic person. However, the water should be between 30-35° C and the arms and legs should be kept out of the water (it is the core temperature that needs to be raised, not the extremities). Gradually raise the water temperature to 42-44° C over a period of five to ten minutes. For severe victims whose temperature has dropped below 30° C, hot bath re-warming should not be undertaken without medical supervision.

Severe Cases

Make no mistake, hypothermia can be fatal. The adage of mountain rescue teams when dealing with hypothermia cases is that "you are not dead till you are warm and dead". This is because severe hypothermia can mimic death and before presuming someone is deceased, re-warming must be carried out until the core temperature reaches at least 35° C. In addition to this, extremely careful handling of the victim is essential to avoid causing erratic heart beats which could lead to a heart attack.

Resuscitation on-site would include the ABCs (airway, breathing and circulation) but no cardiac compression should be applied until a diagnosis of cardiac arrest is certain. As quickly as possible, the victim should be taken to a warm environment and any wet clothing removed. Warm, dry clothes should then put on. The next step would then be to transport the victim to a hospital

for comprehensive assessment and treatment. Expert medical supervision is needed for severe cases of hypothermia as the victims usually require both internal and external re-warming. In many instances, this involves putting the person in a bath where the temperature is 40° C. Core temperature can also be increased with the inhalation of heated, humidified oxygen and the administering of warm IV fluids. At this time, the administration of drugs is usually avoided, and due to slowed gastric emptying and absorption in the stomach, no medication is given by mouth. *Exercise is not used as a method of re-warming due to the increased risk of heart failure related to the release of chemicals from blood retained in the extremities of the body.*

Prevention

The best defense against hypothermia is common sense. All outdoor activities should be planned with safety and hypothermia in mind. Key points to bear in mind are:

- ❏ Taking proper clothing for the worst conditions you might encounter is one of the best precautions.
- ❏ Wool is one of the best materials for all weather warmth.
- ❏ Include a hat in your back-pack. Over 50% of a person's heat loss comes from the head and neck area.
- ❏ Staying dry and avoiding any type of exposure are the key elements in staying warm. Wet clothes lose most of their insulating value.
- ❏ Pack high carbohydrate snacks to keep energy levels up if you are forced to take shelter in poor weather conditions.
- ❏ There is safety in numbers. Don't venture out on the trails or the mountain alone.

What Not To Do

Do not massage the limbs of a hypothermic person. This will only draw heat/blood flow away from the core where it is needed.

- ❏ Never give an alcoholic drink. This will actually inhibit re-warming.
- ❏ Never give a semi-conscious or unconscious person anything to eat or drink due to the possibility of choking.
- ❏ ***Don't treat any hypothermia case lightly.***

Summary

Familiarity with the signs of hypothermia will allow those involved in outdoor sports or recreation to use their own good judgment in situations where hypothermia is a danger. It is important to remember that while some people have miraculously survived under extremely hostile conditions, others have died from "exposure" under mild ones.

Stages of Hypothermia		
Stage	**Core Temp. (°C)**	**Characteristics**
NORMAL:	37.5	
MILD:	38	Increased metabolic rate
	36	Temperature at which hypothermia begins by definition. Shiver to create heat.
	34	Violent shiver, mental changes, amnesia, poor judgement, ataxia, apathy
MODERATE:	32	Stupor, decreased gut mobility
	31	Shivering stops.
	30	Rigors, decreased deep tendon reflexes, dilated pupils, weak pulse, low cardiac output, increased risk of dysrhythmias
	28	Decreased coordination with muscle control, staggered gait, increased risk of ventricular fibrillation , increased blood viscosity, decreased inter vascular volume.
	27	Loss of deep tendon reflexes and voluntary motion.
SEVERE:	26	Acid base change, no pain response, decreased cerebral flow, decreased cardiac output.
	25	Increased risk of pulmonary edema. Increased blood pressure.
	22	Maximum risk of ventricular fibrillation.
	19	Flat ECG.
	18	Asystole.