Long-Term Athlete Development Guide

Cross-Country Skiing **A Sport For Life**

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Introduction

Cross Country Canada is pleased to present its Long-Term Athlete Development (LTAD) Guide, “Cross-Country Skiing – A Sport for Life”. This document introduces and explains the conceptual framework for athlete development that will provide essential guidance for Cross Country Canada, its divisions, clubs and individual members as we pursue the shared vision of establishing a sport system that is in the forefront of theory and practice.

Cross Country Canada’s LTAD Guide, which is consistent with Sport Canada’s Long-Term Athlete Development Resource Paper but customized to cross-country skiing, is a catalyst for change and improvement that can help our sport achieve its goals of fostering both life-long participation and international excellence. To reach these goals will require:

- A cooperative partnership between Cross Country Canada, its member divisions and clubs, within a sport system that recognizes and facilitates the roles of all players, including both those that are integral to CCC and those that are external to the organization (e.g. multi-sport organizations, community recreational organizations, schools, universities, etc.).
- Systematic coaching development at all levels.
- An effective athlete development framework from grassroots to elite levels.
- Programs tailored specifically to an athlete’s development stage.
- Long term strategies rather than a short term focus.

In essence, Cross Country Canada’s LTAD concept will become the touchstone against which the relevance and effectiveness of all operations, functions and supporting systems within our sport will be measured. The concept clearly delineates “what needs to be done” and “why”, if our sport is to flourish. Decisions and actions that determine “how it will be done” and “by whom” will create a comprehensive roadmap to success. Ultimately, by understanding and adhering to LTAD principles and practices, an optimal developmental environment for current and future cross-country skiers will be established.

Dave Rees

Dave Rees
President, Cross Country Canada

Background Information on the LTAD

Sport Canada’s Long-Term Athlete Development (LTAD) Resource Paper “Canadian Sport for Life” sets out a framework for sport development in Canada.

The LTAD concept:

- Is an eight-stage model based on the physical, mental, emotional and cognitive development of children and adolescents. Each stage reflects a different point in athlete development. The first three stages encourage physical literacy and sport experiences for all, while the next four stages are more focussed on development and competitive excellence. The final or overarching stage encourages life-long physical activity and informed healthy lifestyle choices.
- Is “Made in Canada” - recognizing international best practices, research and normative data, while considering the cultural, social and political factors that make Canada unique.
- Supports the four goals of the Canadian Sport Policy – Enhanced Participation, Enhanced Excellence, Enhanced Capacity and Enhanced Interaction.
- Contributes to and promotes a healthy, physically literate nation whose citizens participate in lifelong physical activity.
- Recognizes the need to involve all Canadians in the LTAD process, including athletes with a disability.
- Encourages physical literacy upon which specialized sport excellence can be developed.
- Encourages a better understanding of an optimal competition structure that is appropriate for the various stages of an athlete’s development.
- Describes principles to guide the optimal training, competition and recovery programs that should be provided throughout an athlete’s career.
- Facilitates the optimal involvement of the entire sport continuum, including participants, parents, coaches, officials, specialist consultants, Cross Country Canada, divisions, cross-country ski clubs, municipalities, schools and all levels of government.

This is an inclusive concept that encourages all individuals to be involved in lifelong physical activity and articulates the need for all children, particularly those that have the capacity and interest to become elite athletes, to be given a solid foundation in physical, technical, tactical and mental capacities upon which to build their performance abilities.

Why We Need A LTAD Guide

The need for a systematic LTAD process for cross-country skiing arises from the challenges of meeting the rapidly changing physical activity and sporting interests of Canadian society and competing in a dynamic international sporting arena.

Before the LTAD can be implemented successfully, however, the many shortcomings and resultant consequences that are impeding not only cross-country skiing, but the Canadian sport system in general, must be addressed. Examples of these shortcomings and the consequences are as follows:

Shortcomings. What are the shortcomings?

- Fundamental movement skills and sport skills are not taught properly.
- Typically the most knowledgeable coaches work at the elite level and the least experienced/trained coaches work at the developmental level where experienced/qualified coaches are essential.
- Parents are not educated about LTAD.
- There is no integration between physical education programs in the schools, recreational community programs and elite competitive programs.
- Adult training and competition programs are imposed on developing athletes.
- Training methods and competition programs designed for male athletes are imposed on female athletes.
- Preparation is geared to the short-term outcome and winning — and not on optimal long-term development.
- Chronological rather than developmental age is used in training and competition planning.
- Coaches largely neglect the critical periods of accelerated adaptation to training.

Consequences. What are the results of these shortcomings?

- Poor movement abilities compromise long-term development.
- Lack of appropriate fitness.
- Undeveloped and unrefined skills due to lack of appropriate training.
- Athletic potential is not reached.
- Children dropping out of sport because of unsatisfactory experiences.
- Bad habits developed from focus on winning.
- No systematic development of the next generation of successful international athletes.
- Athletes are pulled in different directions.
- Remedial programs must be implemented by provincial and national team coaches to counteract the shortcomings of athlete preparation.
- Fluctuating international performance due to lack of a comprehensive developmental pathway.

Ten Important Factors Influencing The Athlete Development Process

Research points to 10 important factors that influence athlete development. Building cross-country ski programs around these factors will ensure that athletes can experience both optimal development in their chosen sport and lifelong involvement in physical activity.

ONE
The Ten Year Journey

Overall, scientific research suggests that, in order to achieve excellence in many activities (e.g. the Arts or sporting activities), a substantial investment of time, effort and resources is required. Some authors point out that in overall terms it takes a minimum of 10 years or 10,000 hours of training for an athlete to reach an international elite level of competitiveness within his/her sport. However, it should be noted that this global concept refers to the overall direction of "training" and not necessarily the specific "time on task".

A relevant review of this thinking is provided in "The Path to Excellence", which provides a comprehensive view of the development of U.S. Olympians who competed between 1984 and 1998. Most reported a 12 to 13 year period of talent development between their introduction to their chosen sport and making an Olympic team. Further supporting this understanding of an extended process are Cross Country Canada statistics that indicate that for cross-country skiers this number is approximately 20 years, a figure similar to that for golf (PGA statistics, 2004).

TWO
FUNdamentals

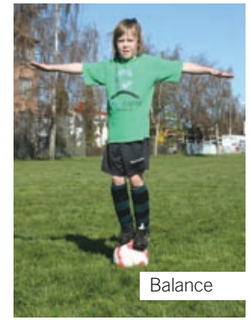
Fundamental movements and skills that provide the base requirements for future advances in movement capacity and athletic skill should be introduced through fun and games at an early age. Without the basic movement skills, a child will have difficulty excelling in most sports. For example, to enjoy baseball, basketball, cricket, football, netball, handball, rugby and softball, the simple skill of catching must be mastered. The emphasis on "FUN" within "FUNdamentals" clearly recognizes fun as an extremely powerful motivating force for children.

FUNdamental movements and specific skills should follow and include basic universal elements such as (but not limited to) running, jumping and throwing. Furthermore, the aspect of an underlying "physical literacy" should be considered as a foundation concept that embraces the ability to execute a broad base of physical competencies.

- FUNdamental movements skills and FUNdamental sports skills = physical literacy.
- Physical literacy refers to competency in movement and sports skills.
- Physical literacy should be developed before the onset of the adolescent growth spurt.

The pictures on the right are some examples of basic movement skills required in all sports.


Throwing


Balance


Jumping


Agility

THREE
Specialization

Typically, sports can be classified along a continuum from early to late specialization activities. Early specialization activities include artistic and acrobatic sports such as gymnastics, diving and figure skating. These differ from late specialization activities in that very complex skills are learned before maturation since it is more difficult for them to be taught afterwards. In addition, this designation has some relevance concerning the eventual point at which the highest level of performance or competitive excellence is attained or consistently demonstrated.

Cross-county skiing clearly falls into the late specialization category. However it should be realized that involvement during the early stages of childhood and athlete development (i.e. the Active Start and FUNdamentals stages) is extremely important. Moreover, foundation cross-country skiing requirements should be introduced during the FUNdamentals stage and firmly established and refined before the end of the Learning to Train stage via appropriately designed activities, events and programs.

FOUR
Developmental Age

It is important to understand the concept of “developmental age”. This refers to the degree of physical, mental, cognitive and emotional maturity as opposed to the well-understood notion of “chronological age”.

Developmental age is highly individual and is an amalgam of a child or adolescent’s physical development (assessed by skeletal maturity or bone age), together with the incorporation of mental, cognitive and emotional maturity. Chronological age refers to the number of years and days elapsed since birth. Athletes of the same chronological age between 10 and 16 can differ by as much as four or five years in their developmental age.

The beginning of the growth spurt and the peak of the growth spurt are very significant considerations in the application of LTAD to training and competition program design. For the most part, they are also relatively easy-to-obtain indications of the general developmental process that can be used to observe

and monitor growth. As a result, LTAD requires the identification of early, average and late maturing individuals in order to help design appropriate training and competition programs in relation to the optimal trainability and readiness of an athlete.

Our sport system frequently selects athletes in the 10 to 16 age range to training camps, provincial teams and other programs offering educational and skill development advantages based on performance. Since early maturers typically have a significant biological advantage over their competitors, this selection process may create obstacles for late maturing athletes who, provided they experience quality coaching throughout that period, often have the potential to become the top athletes. It is therefore essential that administrators/programmers and coaches take developmental age-related considerations into account when designing their programs.

Figure 1 and 2 (below) show the rate of change in height in boys and girls through the key growth period.

Figure 1
Rate of Change in Height & Peak Height Velocity (PHV)
(Adapted from Tanner, 1978 & Kahn, 1999)

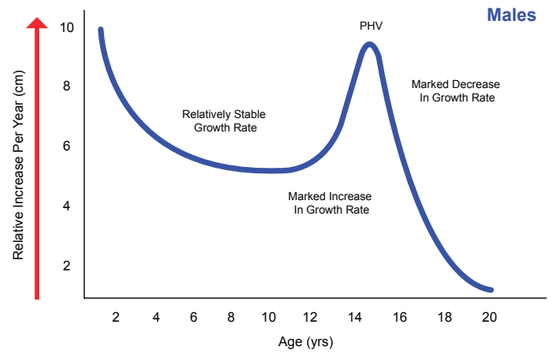
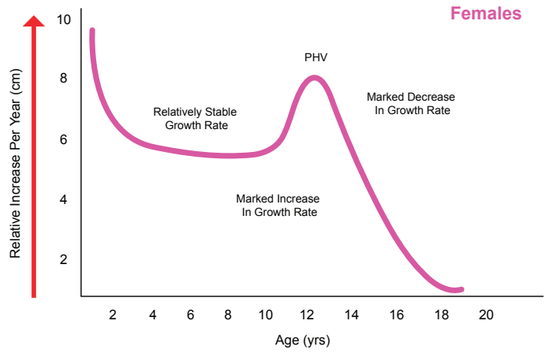


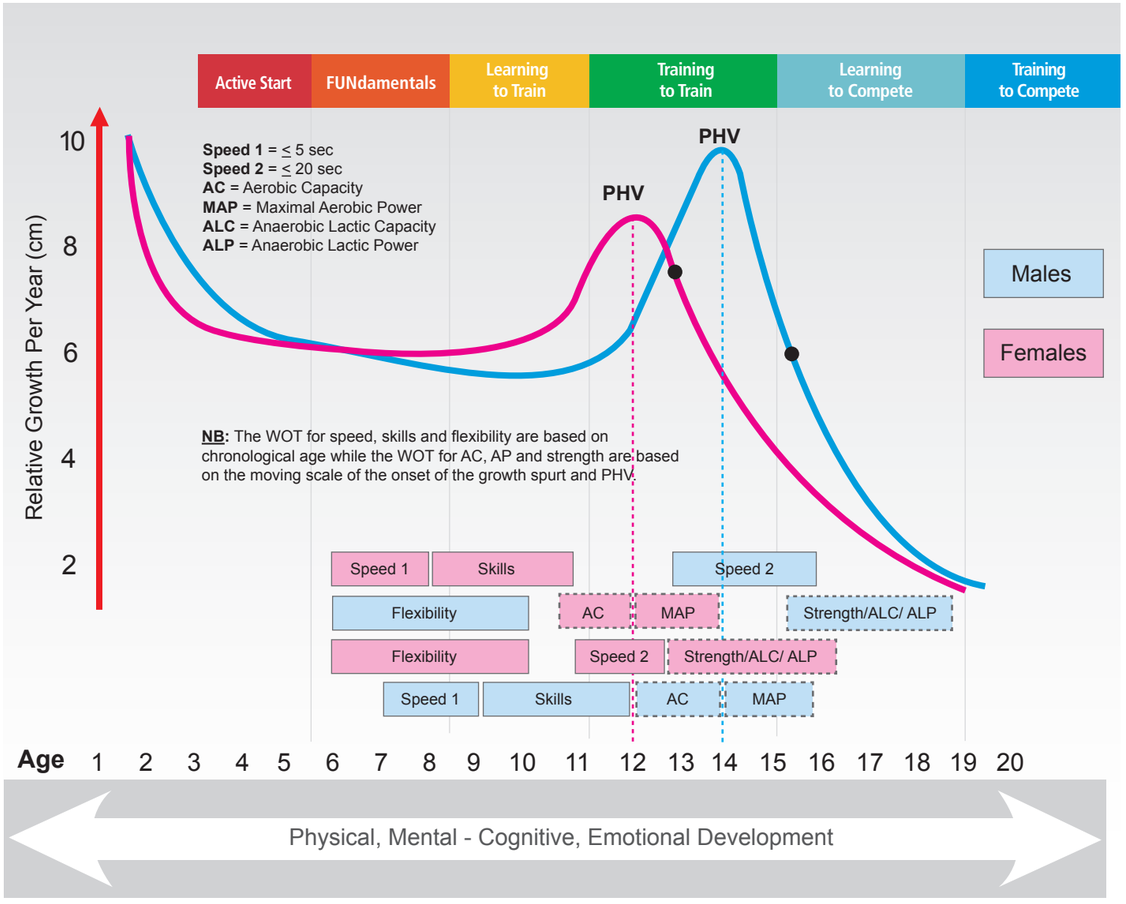
Figure 2
Rate of Change in Height & Peak Height Velocity (PHV)
(Adapted from Tanner, 1978 & Kahn, 1999)



FIVE
Trainability

The terms “adaptation” and “trainability” are often used interchangeably in coaching. However, the difference between them is significant. Adaptation refers to a change or changes in the body as a result of a stimulus that induces functional and/or morphological changes in the organism. Trainability has been defined as the responsiveness of developing individuals to a training stimulus or stimuli at different stages of growth and maturation.

Figure 3 Pacific Sport; Windows of Optimal Trainability (adapted from Balyi and Way, 2005)



All Systems Are Always Trainable!
Canadian Sport for Life

Accordingly, periods of sensitivity to particular emphases of training, the so-called “windows of trainability” in the table above, are dependent on the maturation levels of the athlete. For this reason, the timing of training emphasis differs depending on whether athletes are early, average or late maturers. For example, the first of two windows of accelerated adaptation to strength training for females occurs immediately after Peak Height Velocity (PHV) and the second begins with the onset of menarche. For males, there is one window and it begins 12 to 18 months after PHV.

The five basic S’s of training and performance are Stamina (Endurance), Strength, Speed, Skill and Suppleness (Flexibility). (Dick, 1985)

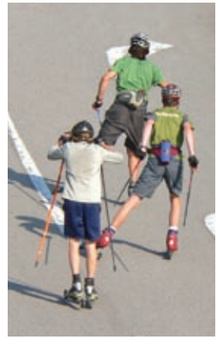
Stamina (Endurance)
The window of optimal trainability occurs at the onset of the growth spurt. Aerobic capacity training is recommended before children reach PHV. Aerobic power should be introduced progressively after the growth rate decelerates.

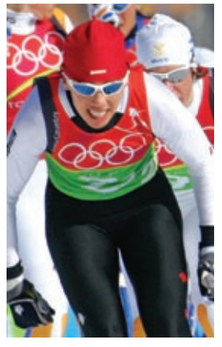
Strength
The window for trainability for girls is immediately after PHV or at the onset of the menarche (first menstruation) while for boys it is 12 to 18 months after PHV.

Speed
For boys, the first speed training window occurs between seven and nine years of age and the second window occurs between 13 and 16 years of age. For girls, the first speed training window occurs between six and eight years of age and the second window occurs between 11 and 13 years of age.

Skill
The window for optimal skill training begins at nine years of age for boys and eight years of age for girls. This window ends at the onset of the growth spurt.

Suppleness (Flexibility)
The window of optimal trainability for suppleness in both boys and girls occurs between six and 10 years of age. Special attention should be paid to flexibility during PHV.





SIX
Physical, Mental, Cognitive, Ethical and Emotional Development

A major objective of LTAD and one that reflects Canadian values is a holistic approach to athlete development. In addition to physical, technical and tactical development - including decision-making skills – the mental, cognitive and emotional development of athletes needs to be addressed. This includes an emphasis on ethics, fair play and character building. All programming should be designed to consider the athletes' cognitive ability to address these concepts throughout the various stages. In addition, coaches, parents and sport administrators need to understand that when programming for children and adolescents in the short-term, the longer term ramifications need to be taken into account so as to act in the participants' best interests.

SEVEN
Periodization

Periodization is time management applied to training. As a planning technique, it provides the framework for arranging the complex array of training processes into a logical and scientifically-based schedule to bring about optimal improvements in performance.

Periodization sequences the training and competition components into months, weeks, days and sessions. It is situation specific depending upon priorities and the time available to bring about the required training and competition improvement. Longer term planning involving the training/competition year and multiples of years is required in order to truly formulate a logical and sequenced overall activity/sports experience.

In the LTAD context, periodization connects the stage the skier is in to the requirements of that stage. It is therefore an essential component of optimal sports programming and athlete development at all levels. Refer to the "Appendices" section for example yearly training plans.

EIGHT
Competition Calendar

Optimal competition calendar planning at all stages is critical to athlete development. At certain stages, development of physical capacities takes precedence over competition and at other stages the ability to compete becomes the focus. Competition schedules should therefore be selected by the coach and athlete based on the athlete's developmental needs.

The system of competition makes or breaks athletes!
Canadian Sport for Life

The LTAD design recommends a sport-specific system of training and competition that is optimized for the abilities of athletes during the various developmental stages. The following factors should be considered when planning:

- Optimal training to competition ratios are required for all stages of LTAD except Active Start.
- The level and length of the competitive season should be aligned with the changing needs of the developing athlete progressing through LTAD.
- At the Learning to Train and Training to Train stages, an insufficient number of competitions (training to competition ratio) will result in a lack of sport skills to build on in later stages.
- At all stages, the appropriate level of competition is critical to the technical, tactical and mental development of the athlete.
- The "competition" and/or evaluation needs of athletes may not always be met by using a simplified version of a "senior" competition format.
- The competition calendar should be planned to enhance the optimal training and performance of athletes depending upon their LTAD stage.
- A systematic competition and training review needs to be undertaken periodically with regard to national, provincial and club calendar planning in order to provide the best possible pathway for athletes involved in all stages of LTAD.

Figure 4 Competitor Pathway for Junior Cross-Country Skiers

NINE
System Alignment

Sport Canada's LTAD concept is a framework for full sport system alignment in Canada, integrating health and education with sport and physical activity. It is also a tool for motivating change towards more effective organization, alignment and integration within each national sport organization, such as Cross Country Canada.

It is important that all members of the cross-country skiing community work together to implement the right programs and ensure a sport system that will produce optimal conditions for participation, skill development, training and competition.

To date Cross Country Canada has monitored the development of the LTAD concept closely, and has applied the principles effectively to recent program development in the areas of:

(1) athlete development (the revised Bunnyrabbit, Jackrabbit and Track Attack programs), and

(2) coach development (the new competency-based NCCP).

This is a great start, but only a beginning. The new LTAD concept is an important influence in Cross Country Canada's current Strategic Plan, and ultimately it will provide guidance to all areas of Cross Country Canada's operations.

TEN
Continuous Improvement

The concept of continuous improvement, which permeates LTAD, is drawn from the respected Japanese industrial philosophy known as Kaizen. Continuous improvement ensures that LTAD responds and reacts to new scientific and sport-specific innovations and observations and is subject to continuous research in all its aspects. This concept extends to all aspects of Cross Country Canada and its partner organizations (divisions and clubs) where efforts to continually improve and evolve should be clear expectations if a vibrant and progressive sports community is to be maintained. Periodic updates to Cross Country Canada's LTAD guide will be undertaken at regular intervals in the future based on recommendations from leaders in the Canadian sport community.

Physical Literacy: Movements and Skills

Through the improvement of physical literacy, the LTAD will help develop lifelong involvement in physical activity and sport. The table below provides an overview of the range of FUNdamental movements that underscore a competent physical literacy.

Travelling Skills

- Climbing
- Galloping
- Gliding
- Hopping
- Jumping
- Leaping
- Poling
- Running
- Sculling
- Skating
- Skipping
- Sliding
- Swimming
- Swinging
- Wheeling

Object Control Skills

- Kicking
- Punting
- Rolling (ball)
- Strike (ball, puck, etc.)
- Throwing

Receiving:

- Catching
- Stopping
- Trapping

Travelling with:

- Dribbling (feet)
- Dribbling (hands)
- Dribbling (stick)

Receiving and Sending:

- Striking (bat)
- Striking (stick)
- Volleying

Balance Movements

- Balancing/Centering
- Body Rolling
- Dodging
- Eggbeater
- Floating
- Landing
- Ready position
- Sinking/Falling
- Spinning
- Stopping
- Stretching/Curling
- Swinging
- Twisting/Turning


Skipping


Hitting


Agility


Dribbling


Co-ordination


Kicking


Balance While Moving

Measuring Growth

Coaches and parents can use stature measurements (height) before, during and after maturation as a guide for tracking the development age of children. Tracking allows coaches to address the critical or sensitive periods of physical development (endurance, strength, speed and flexibility) and skill development.

The age of an athlete can be examined from seven different perspectives:

1. Chronological age
2. Biological age
3. Developmental age
4. Sport-specific training age
5. Relative age
6. Skeletal age
7. Training age

How to Measure Growth Spurt

- Stand straight against a wall, no shoes, heels touching the wall.
- Measure from floor to top of head.
- Measurements should be taken at the same time of day (AM or PM).

Phase 1: Age 0 to 6
- Very rapid growth.
- Measure standing height and weight on birthday.

Phase 2: Age 6 to the Onset of Growth Spurt
- Steady growth until the onset of growth spurt.
- Measure standing height and weight every three months.
- If measurement takes place outside of home, replace birthday with an annual starting point of measurements.

Phase 3: From the Onset of Growth Spurt to Peak of Growth Spurt
- Rapid growth until peak is reached.
- Measure standing height, sitting height and arm span every three months.

Phase 4: Peak of Growth Spurt to Slow Deceleration
- Rapid deceleration.
- Measure standing height, sitting height and arm span every three months.

Phase 5: From Slow Deceleration to Cessation
- Slow deceleration of growth until cessation of growth.
- Measure standing height every three months.

Phase 6: Cessation
- Cessation of growth.
- Measure height and weight on birthday.

LTAD Framework For Cross-Country Skiing

Ski Playground to Podium

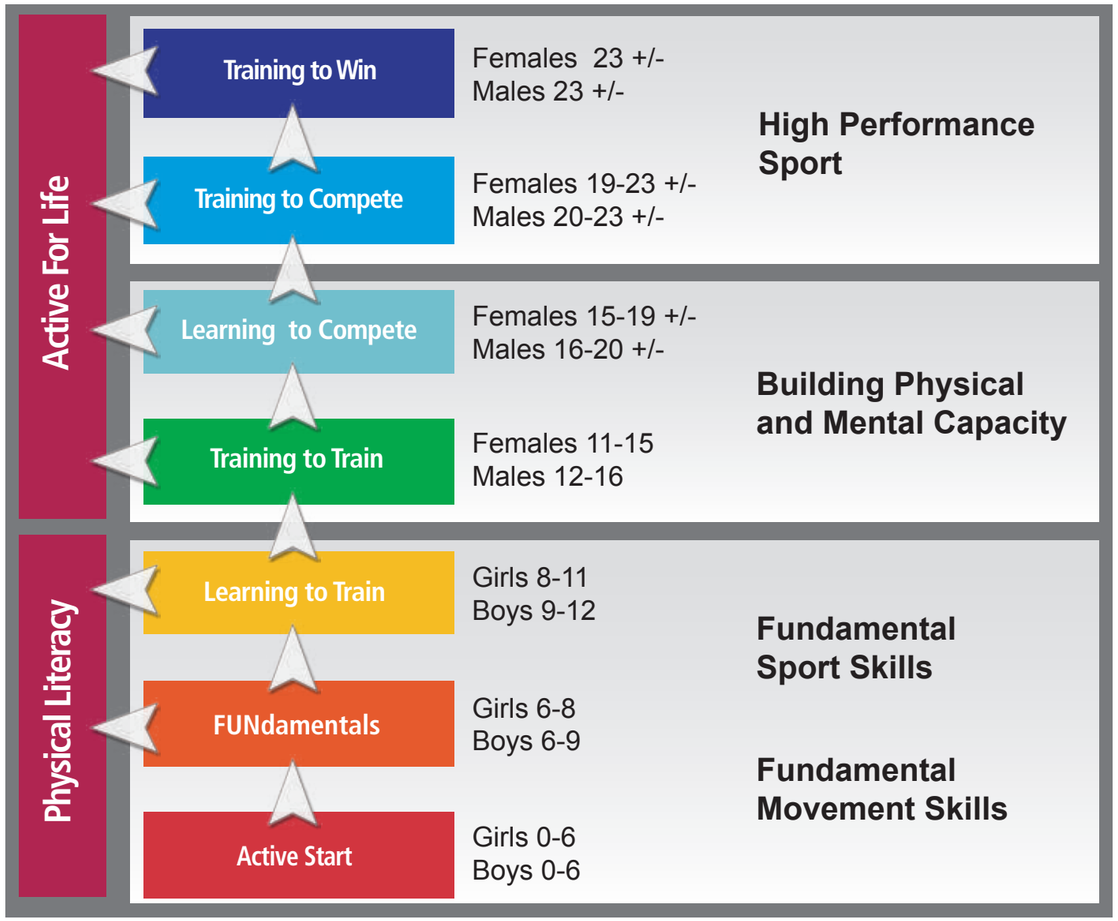
Cross-country skiing is a late specialization sport. During the first three stages of the LTAD, children grow and improve within the sport through programs permitting a broad exposure to activities that develop overall motor and sport skills. Following the first three stages, there is a transition to either further development and excellence in cross-country skiing or life-long participation in skiing and/or other sports at the recreational or less competitive level. For athletes who wish to pursue excellence, increasing specialization in cross-country skiing and an expanding focus on competition permit them to mature athletically and aspire to national and international podiums. Regardless of the level of excellence or sport-mastery achieved however, participation in cross-country skiing – a "sport for life" - can enhance the health, fitness and mental well-being of Canadians of all ages.

The first three stages encourage physical literacy and sport for all:
1. Active Start
2. FUNdamentals
3. Learning to Train

The next four stages focus on development and competitive excellence:
4. Training to Train
5. Learning to Compete
6. Training to Compete
7. Training to Win

The final stage encourages life-long physical activity:
8. Active for Life

Figure 5

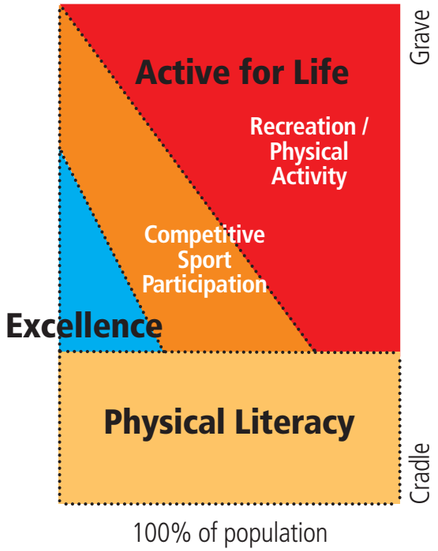


Stages of Development

This document - the LTAD Guide for cross-country skiing - utilizes a number of stages that are seamlessly linked in keeping with Sport Canada's generic LTAD concept, but with a cross-country ski-specific focus. The latter focus reflects the reality and demands of the sport at the highest level, yet retains, at its core, the notion of age and ability-appropriate programming and evaluation.

To promote each child's healthy and logical development, the LTAD identifies sequential stages for training and competition that respects his/her physical, mental and emotional development. This approach encourages lifelong physical activity for athletes of all levels of ability and disability, and it also provides an effective route for athletes to pursue excellence at the national and international levels of competition.

Figure 6



The following sections provide an overview of the age groups in question for each stage and the relative importance of chronological and developmental age, together with a summary of the key objectives that are suggested at each level.

Active Start Males and Females 0-6

Cross Country Canada (CCC) encourages children to be involved in lifelong activity and to begin cross-country skiing at an early age through the Bunnyrabbit Program.

This is an essential period for acquiring fundamental movement skills that lay the foundation for more complex movements.

FUNdamentals Males 6-9 Females 6-8

Fundamental movement skills are mastered, motor development emphasized and basic cross-country ski skills learned. For optimal sport specific acquisition, all the basic ski skills, both classic and skating, should be learned before the end of this period.

To help children learn these skills, CCC's Jackrabbit Program provides guidance on equipment, technique, the appropriate number of practice sessions per season and the other elements that constitute an appropriate sport program that conforms to LTAD principles.

Learning to Train Males 9-12 Females 8-11

Important period for motor development, and windows of optimal trainability for motor-coordination. Children are developmentally ready to acquire the general sport skills that will be the cornerstone of their athletic development. Fitness becomes increasingly important.

CCC's Track Attack Program is designed to promote the continued development of physical literacy and fitness, and to enhance competence in the basic skills required to excel in cross-country skiing.

Training to Train Males 12-16 Females 11-15

Important period for developing aerobic capacity, which is especially critical for cross-country skiing (a lot of skiing at low intensity!).

Social and emotional considerations are very important. Team building, group interaction and social events should be emphasized.

Learning to Compete Males 16-20 +/- Females 15-19 +/-

Fitness preparation, sport and individual specific skills are developed. The development of self awareness and independence should be emphasized.

The gradual seamless integration of training and racing into the overall timetable and lifestyle of the aspiring competitive athlete.

Training to Compete Males 20-23 +/- Females 19-23 +/-

Important period for individualized fitness preparation. Fitness and medical monitoring is increasingly sophisticated, and sport and individual specific skills are mastered. Self-awareness and independence become increasingly important.

Athletes learn to compete internationally.

Training to Win Males 23 +/- Females 23+/-

During this stage athletes focus on high performance and undertake multi-year preparations for major events (i.e. Olympics, World Championships).

All aspects of training and performance are highly individualized.

Podium Performances.

Active for Life This stage can be entered at any age.

There is a better opportunity to be Active for Life if physical literacy is achieved before the Training to Train stage.

Stages of LTAD

Active Start

Ages 0 to 6 years (males and females)

This is an important period for acquiring the fundamental movement skills that lay the foundation for more complex movements, thereby preparing children for a physically active lifestyle.

Physical activity is essential for healthy development of children. Among its other benefits, physical activity:

- enhances development of brain function, coordination, social skills, gross motor skills, emotions, leadership and imagination;
- helps to build confidence and positive self-esteem;
- helps to build strong bones and muscles, improve flexibility, develop good posture and balance, improve fitness, reduce stress and improve sleep;
- promotes healthy weight; and
- helps children learn to move skillfully and learn to enjoy being active.

Young children should be physically active through active play. Physical activity should be fun and a part of the child's daily life, not something required.

Organized physical activity and active play are particularly important for the healthy development of children with a disability if they are to acquire habits of lifelong activity.

Objective:

- To develop fundamental movements and link them together into play.

The goals include:

- Providing organized physical activity (including outdoor activities) for at least 30 minutes a day for toddlers and 60 minutes a day for preschoolers.
- Providing outdoor physical activity every day regardless of the weather.
- Providing unstructured physical activity - active play - for at least 60 minutes a day, and up to several hours per day for toddlers and preschoolers. Toddlers and preschoolers should not be sedentary for more than 60 minutes at a time except while sleeping.
- Introducing children to cross-country skiing early (e.g. three years of age).
- Teaching children to cross-country ski through an organized mix of play and discovery in situations in which they learn to ski naturally, with limited formal instruction.
- Frequent use of ski facilities with ski playgrounds/terrain parks during the snow season.
- Developing fitness and movement skills as a FUN part of daily life.
- Ensuring positive experiences through the use of appropriate equipment.
- Allowing children to explore risk and limits in safe environments.
- Improving basic movement skills such as gliding, running, jumping, twisting, balance while moving, kicking, throwing and catching. This means introducing children to activities that incorporate a variety of movement skills - activities such as gymnastics, dance, swimming, cross-country skiing, etc. These basic movement skills are the building blocks for more complex movements.
- Designing activities that help children to feel competent and comfortable.
- Ensuring that games are non-competitive and focus on participation.
- Ensuring that activities are gender-neutral and inclusive so that active living is equally valued and promoted for all children (because girls tend to be less active than boys and children with a disability less active than their peers).

Cross Country Canada encourages children to be involved in lifelong activity and to begin cross-country skiing at an early age through the Bunnyrabbit Program.

Suggested material:

- CCC Bunnyrabbit Booklet.
- NCCP Introduction to Community Coaching Reference Material.

FUNdamentals

Ages 6 to 9 years (males), 6 to 8 years (females)

At this stage fundamental movement skills are mastered, motor development emphasized and basic cross-country ski skills learned. For optimal sport-specific acquisition, all basic ski skills, both classic and skating, should be learned before the end of this period.

Objectives:

- To develop all fundamental movement skills and build overall motor skills.
- All basic cross-country ski skills should be learned by the end of this stage.

Windows of Optimal Trainability:

- Speed development.
- Flexibility development.

The goals include:

- Encouraging FUN and participation.
- Developing the ABCs of athleticism - agility, balance, coordination and speed.
- Participation in many activities/sports 4-6 times a week, year-round.
- Frequent cross-country skiing during the snow season (several times a week).
- Good technique habits developed through repeated practice; use the Jack Rabbit Program "Snow Goals" Awards to encourage time on snow.
- Continued use of ski playgrounds/terrain parks.
- Developing basic cross-country ski skills (both classic and skating techniques); equal use of techniques; developing downhill abilities.
- Utilizing games to develop technique, speed, skills and fitness.
- Providing programs that are well-structured and monitored. No periodization.
- Integrated mental, cognitive and emotional development.
- Introducing basic flexibility exercises.
- Developing linear, lateral and multi-directional speed with the duration of repetitions less than five seconds.
- Introducing strength training exercises using the child's own body weight as well as medicine balls and Swiss balls.
- Developing a team/social atmosphere (increasingly important towards the end of this stage).
- Focussing on balance, agility and rhythm (on-snow).
- Introducing competition in a team environment whenever possible.
- Encouraging inter-club social, skill and fitness-oriented ski activities (e.g. camps during the ski season).

Psychological training:

Objectives:

- Gain an awareness of the importance of mental skills.
- Exposure to positive thinking skills to build confidence and the ability to cope with stress.

To help children learn these skills, CCC's Jackrabbit program provides guidance on equipment, technique, the appropriate number of practice sessions per season and other elements that constitute an appropriate sport program that conforms to LTAD principles.

Suggested material:

- CCC Jackrabbit Booklet.
- NCCP Community Coaching Reference Material.

Children who do not develop their fundamental motor skills by 12 years of age are unlikely to reach their genetic athletic potential.

Learning To Train

Ages 9 to 12 years (males), 8 to 11 years (females); change in height cue to be utilized as a guide to appropriate programming towards end of this stage.

This is an important period for motor development, and an optimal window of trainability for motor-coordination. At this stage, children are developmentally ready to acquire the general sport skills that will be the cornerstone of their athletic development.

Objectives:

- To further develop all fundamental movement skills and general overall sports skills. Otherwise, a significant window of opportunity is lost, compromising the ability of the young athlete to reach full potential.
- All basic cross-country ski skills should be refined by the end of this stage.

Windows of Optimal Trainability:

- Motor skills and coordination development.
- Major skill learning phase.

The goals include:

- Developing all basic sport skills (physical literacy) before the athlete enters the Training to Train stage.
- Introducing hopping and bounding exercises or routines, or wheeling up gradients, to aid in strength development.
- Utilizing games to develop skills, speed, power and aerobic fitness.
- Further developing strength using exercises that incorporate the child's own body weight as well as medicine balls and Swiss balls.
- Further developing flexibility through exercises.
- Further developing good ski technique habits through repeated practice and the use of games that reinforce the technique being taught.
- Further developing speed by using specific activities that focus on agility, quickness and change of direction.
- Structuring competition to address differences in training age and abilities.
- Narrowing the focus to three sports. Encouraging participation in different sports such as canoeing, cycling, swimming, etc.
- Sport specific practice sessions three times a week during the fall and ski season; participation in other sports three times a week during the ski season and more often in the off-season.
- Building adventure-based activities into the seasonal plan.
- Introducing dryland ski techniques – ski walking and ski striding.
- Emphasizing group interaction, team building and social activities.
- Integrating mental, cognitive and emotional development.
- Introducing ancillary capacities.
- Encouraging unstructured play.

Psychological training:

Objectives:

- Understand the importance of practicing basic mental skills.
- Develop an awareness of how performance unfolds from a mental perspective.

To-do list:

- Introduce pre-race preparation.
- Introduce tactical skills.
- Introduce the mental skills of:
  - Constructive self-talk.
  - Imagery.
  - Confident behaviour.

Cross Country Canada's Track Attack program for children 10 to 12 years of age is designed to promote the continued development of physical literacy and fitness, and to enhance competence in the basic skills required to excel in cross-country skiing.

Suggested material:

- Track Attack Log.
- NCCP CCI-L2T (Dryland) Reference Material.
- NCCP CCI-L2T (On-Snow) Reference Material.

The Learning to Train and Training to Train stages are the most important stages of athletic preparation. During this period, we make or break an athlete!

Canadian Sport for Life

Training to Train

Ages 12 to 16 years (males); 11 to 15 years (females); programming dependent upon change in height cue (Peak Height Velocity).

Optimal aerobic trainability begins with the onset of Peak Height Velocity (PHV), the major growth spurt during maturation. The Training to Train stage is therefore very important for developing aerobic capacity, which is especially critical for the sport of cross-country skiing. This means athletes at this stage of development will be doing a lot of skiing at low intensity!

Objectives:

- To build an aerobic base, develop speed and strength and further develop and consolidate sport specific skills.

Windows of Optimal Trainability:

- Aerobic capacity development.
- Strength development (females).
- Speed development for females (at the start of this stage) and males (at the end of this stage).

The goals include:

- Ensuring social and emotional considerations are addressed by placing an appropriate emphasis on team-building, group interaction and social activities.
- Ensuring the training focus is tied to individual stage of maturation.
- Making aerobic training a priority after the onset of PHV while maintaining or further developing levels of skill, speed, strength and flexibility.

- Emphasizing flexibility training given the rapid growth of bones, tendons, ligaments and muscles.
- Frequent musculoskeletal evaluations during PHV.
- Further developing and refining all sport-specific skills.
- Refining all ski techniques.
- Developing mental, cognitive and emotional skills.
- Introducing systematic medical monitoring.
- Further developing and refining sport specific skills.
- Sport specific-training six times per week in the ski season with some complementary training; maintaining training six times per week in the off-season including incremental specific training with the major emphasis still being on complementary sports.
- Narrowing the focus to two sports based on predisposition.
- Further developing ancillary capacities.
- Planning and preparing for a best performance at one event; utilizing single and double periodization as the optimal framework of preparation.
- Ensuring the focus during competitions is on learning the basics as opposed to competing, although athletes should ski to win and to do their best.
- Introducing free weights.
- Educating athletes about the nutritional needs of competitive cross-country skiers.
- Developing skills to cope with the physical and mental challenges of competition.
- Integrated mental, cognitive and emotional development.
- Appropriate adjustment of nutritional intake to accommodate increased training load.
- Introducing basic sport science and sport medicine support.

Psychological training:

Objectives:

- Understand personal specific mental skill needs.
- Be able to set realistic, but challenging goals for the season.

To-do list:

- Introduce mental performance monitoring for competitive situations.
- Further develop pre-race preparation skills.
- Develop a range of tactical skills.
- Develop time management skills.
- Further develop the mental skills of:
  - Constructive self-talk.
  - Imagery.
  - Confident behaviour.

Suggested material:

- NCCP CCI-T2T (Dryland) Reference Material.
- NCCP CCI-T2T (On-Snow) Reference Material.

Learning to Compete

Ages 16 to 20+/- years (males), 15 to 19+/- (females); programming dependent upon change in height cue (Peak Height Velocity).

During the Learning to Compete stage there should be a gradual, seamless integration of training and competitions into the overall timetable and lifestyle of the athlete, while the emphasis on fitness preparation and the development of sport specific skills continues.

Objectives:

- To develop aerobic capacity and power.
- To develop sport-specific and individual specific skills.
- To develop self-awareness and independence.

Windows of Optimal Trainability:

- Strength development (males).
- Post PHV aerobic power development.

The goals include:

- Refining all ski techniques.
- Improving technique adaptations to various snow, track and terrain conditions.
- Improving technique efficiency when dealing with a high level of fatigue.
- Developing anaerobic lactic power (20-60 second intervals).
- Introducing plyometric strength workouts.
- Maintaining flexibility.
- Sport specific technical, tactical and fitness training 9 to 12 times per week.
- Developing format and distance-specific tactical preparation skills (individual sprint, team sprint, mass start, interval start, relays; long versus short distance).
- Refining mental, cognitive and emotional skills.
- Developing/implementing systematic post-intensity recovery strategies.
- Providing appropriate sport science and sport medicine support.
- Consistent monitoring of training and recovery.
- Consistent medical monitoring including haemoglobin (blood sample) levels 3-4 times per year.
- Frequent musculoskeletal evaluations during PHV.
- Appropriate adjustment of nutritional intake to accommodate increased training load.
- Further developing ancillary capacities.
- Utilizing single, double and triple periodization as the optimal framework of preparation.
- Individually tailoring fitness programs, recovery programs, psychological preparation and technical development.
- International competitive experience, at the end of this stage, for top level athletes.

Psychological training:

Objectives:

- Increase self-awareness of personal psychological performance factors (e.g. confidence, competitiveness, mental toughness, work ethic, etc.) in order to identify personal performance needs.
- Learn to self-evaluate psychological performance – for both training and competitive situations.

To-do list:

- Refinement of pre-race preparation and race plans.
- Apply mental plans to practice sessions.
- Introduce mental performance monitoring for practice and competitive situations.
- Further develop tactical skills.
- Further develop time-management skills.

Suggested material:

- NCCP CCD – L2C Reference Material (to be developed).
- NCCP CCD – T2C Reference Material (to be developed).

Training to Compete

Ages 20 to 23+/- (males), 19-23+/- (females)

The goal at this stage is to provide athletes with a highly individualized training program. Fitness and medical monitoring requirements are increasingly sophisticated.

Objectives:

- To optimize fitness preparation.
- To master individual and sport-specific skills.
- To further develop self-awareness and independence.

The goals include:

- Improving individual areas of weakness.
- Optimizing both lifestyle and training environment for high performance goals.
- Advanced mental preparation.
- Optimizing ancillary capacities.
- Further developing self-awareness and independence.
- Sport specific technical, tactical and fitness training 9-12 times per week.
- Optimizing technical skills in competitive situations (at high intensity).
- Learning to compete internationally.
- Further refining all ski techniques.
- Optimizing technique adaptations to various snow, track and terrain conditions.
- Optimizing format and distance-specific tactical preparation (individual sprint, team sprint, mass start, interval start, relays; long versus short distance).
- Implementing well-developed post-intensity recovery strategies.
- Appropriate sport science and sport medicine support.
- Appropriate monitoring of training and recovery.
- Appropriate nutritional intake to accommodate increased training load.
- Individually tailor to a greater degree - fitness programs, recovery programs, psychological preparation and technical development.
- Evaluating race specialization options (sprint versus distance) for training and performance.
- Optimizing technical skills in competitive situations (at high intensity).
- Single, double or triple periodization.
- Optimizing fitness preparation and sport, individual and position-specific skills as well as performance.
- Preparation that addresses each athlete's individual strengths and weaknesses.
- Narrowing the focus to one sport.

Psychological training:

Objectives:

- Ongoing refinement of personalized practice and race plans.
- Increased attention to monitored psychological performance.
- Gain a comprehensive understanding of the critical factors that affect the athlete's ideal performance state.
- Have the ability to adjust emotions and focus to gain control over confidence and performance outcome.

To-do list:

- Regular use of practice and race plans.
- Use of mental performance monitoring for practice and competitive situations.
- Further develop tactical skills.

Training to Win

Ages 23+/- (males), 23+/- (females)

During this stage athletes focus on high performance and undertake multi-year preparations for major events (i.e. Olympics, World Championships). High performance sport specialist support is optimized, as is fitness and medical monitoring. All aspects of training and performance are highly individualized.

Objectives:

- Podium performances.

The goals include:

- Full time commitment to cross-country skiing.
- All of the athlete's physical, technical, tactical (including decision-making skills), mental, and personal and lifestyle capacities are fully established and the focus of training has shifted to the maximization of performance.
- Improving physical capacities by increasing and maximizing the training load (volume and intensity) that an athlete can handle.
- Refining technical, tactical and mental skills.
- Individualizing all aspects of training and performance to maximize optimization.
- Sport specific technical, tactical and fitness training 9-15 times a week.
- Based on predisposition, optimizing event specialization (sprint versus distance) for consistent, repeatable performances.
- Maximizing high performance sport specialist support, including fitness and medical monitoring.
- Improving individual areas of weakness and capitalizing on strengths.
- Modelling all possible aspects of training and performance.
- Frequent prophylactic breaks.
- Maximizing ancillary capacities.
- Maximizing fitness preparation and sport and individual-specific skills as well as performance.
- Allowing frequent preventative breaks to prevent physical and mental burnouts.
- Utilizing single, double, triple and multiple periodization as the optimal framework of preparation.

Psychological training:

Objectives:

- Demonstrate the ability to self-regulate and adjust focus when under pressure.
- Demonstrate the ability to perform successfully in stressful situations; become more focussed and effective under pressure (that is, exhibit mental toughness).
- Demonstrate decision accuracy so that race decisions are rarely flawed and errors are a consequence of conditions/situations beyond skier control.

To-do list:

- Continue use of practice and race plans.
- Continue mental performance monitoring for practice and competitive situations.
- Total focus on cross-country ski performance.

Active For Life

This stage can be entered at any age, but ideally it will follow the Learning to Train stage or take place when an athlete leaves the competitive stream.

There is a better opportunity to be Active for Life if physical literacy is achieved before the Training to Train stage.

Objectives

- Life-long physical activity and participation in sport.
- A smooth transition from a skier's competitive career to lifelong physical activity and participation in sport.

Cross Country Canada's Long Term Athlete Development (LTAD) Guide, "Cross Country Skiing – A Sport for Life" encourages individuals to be physically active for life by:

- focusing on being physically active with a daily minimum of either 60 minutes moderate activity or 30 minutes intense activity (for adults);
- moving from one sport to another - for example, an alpine skier becomes a cross-country skier, or a cross-country skier takes up cycling;
- moving from one aspect of cross-country skiing to another. For example, a former elite competitor becomes a guide for blind skiers, a coach takes up skiing in loppets, or a loppet skier takes up backcountry skiing;
- moving from highly competitive sport to lifelong competitive sport through age group races and/or loppets;
- moving from competitive sport to recreational activities such as recreational skiing, hiking and cycling;
- moving to sport-related careers such as coaching, sport administration, small business enterprises or sport media upon retiring from competitive skiing; and/or
- moving from competitive sport to volunteer involvement as coaches, officials or administrators.

Additional Supporting Factors

There is a smorgasbord of holistic elements to sport that the aspiring athlete must be aware of and adept at executing such as health, nutrition, fitness maintenance, time management, career planning and logistical strategies (travel, equipment, clothing, communication, etc) if he/she are to be successful. In addition, athletes must be aware of the specific aspects of their sport relating to competitions such as warm-up/preparation routines or choices around competition calendar and schooling.

These ancillary elements support the technical, tactical, physical and psychological elements as well as the components of health and lifestyle.

An Integrated Development System For Cross-country Skiing

It will require a coordinated effort by the entire cross-country ski community to create a truly integrated, leading edge development system that will place Canada among the leading cross-country ski nations in the world. In order to achieve this objective, it is important that all of the primary stakeholders acknowledge their roles and responsibilities and be aware of those of the other key groups involved in the developmental process. The traits or qualities of each group would include:

Parents
- Providing support and guidance and making their child's involvement in cross-country skiing enjoyable.
- Being educated about cross-country skiing and how one can progress through the sport.
- Understanding the concept that increased activity reverses the current trends in childhood and adult obesity and cardiovascular disease.

Athletes
- Enjoying the sport.
- Developing competent physical literacy.
- Developing competent cross-country ski skills (both classic and skating techniques).
- Becoming self-reliant and demonstrating independent initiative in learning and developing skills.

Coaches
- Being educated.
- Having a thorough understanding of the LTAD principles for cross-country skiing.
- Adhering to Cross Country Canada's Coaches Code of Ethics.
- Understanding where and how they fit into the "system".
- Committing to supporting athletes in achieving their goals.

Clubs
- Providing proper training and competition facilities.
- Providing a support structure (coaching, resources, etc).
- Operating developmental cross-country ski programs.

Cross Country Canada/Divisions
- Ensuring appropriate programming is in place for use by clubs, coaches, officials, etc.
- Being a source of information, expertise and support; providing necessary information and communications in the development of athletes.

Coaching: NCCP And LTAD

Athlete & Coach Development Progression

Age	LTAD Stage	NCCP Context
23 +/- males 23 +/- females	Training to Win (T2W)	Competition Coaching: High Performance (CCHP)
20 - 23 +/- males 19 - 23 +/- females	Training to Compete (T2C)	Competition Coaching: Development (CCD – T2C)
16 - 20 +/- males 15 - 19 +/- females	Learning to Compete (L2C)	Competition Coaching: Development (CCD – L2C)
12 - 16 males 11 - 15 females	Training to Train (T2T)	Competition Coaching: Introduction (CCI – T2T)
9 - 12 males 8 - 11 females	Learning to Train (L2T)	Competition Coaching: Introduction (CCI – L2T)
6 - 9 males 6 - 8 females	FUNdamentals	Community Coaching: (CC)
0 - 6	Active Start	Community Coaching: (ICC)

Summary

In summary, the LTAD approach to athletic development:

- is an initiative of Sport Canada to further sport excellence and the well-being of Canadians;
- provides an opportunity for change and improvement;
- identifies the shortcomings of the broader Canadian sport system as well as the sport system for cross-country skiing, and provides guidelines for addressing them;
- provides a framework for reviewing current practices, developing new initiatives and standardizing programs;
- provides key partners with a coordinated structure;
- is athlete-centred, from a child's first involvement in cross-country skiing to the transition to lifelong physical activity or other sport-related activities;
- establishes a clear pathway from ski playground to podium and/or being active for life;
- helps all children to be physically literate (competent in fundamental movement skills for sport and physical activity);
- provides guidelines for planning for optimal performance for all stages of athlete development;
- establishes clearly that during the early stages of development it is imperative that sport development programs should be designed around critical periods of accelerated adaptation to training (WOT);
- recognizes that children play sport to have FUN;
- integrates the needs of athletes with a disability into the design and delivery of cross-country ski programs; and
- provides an aligned and integrated model for delivering systems including:
  - long-term athlete development – technical, physical, tactical and behavioural,
  - physical activity programming, and
  - long-term coaching development.

Yearly Training Plan Guidelines – Training to Train

YTP Guidelines for T2T

For later part of stage: Females 14-15, Males 15-16

= Priority 1 = Priority 2 = Priority 3

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Periods	General preparation period			Specific preparation period			Pre-competition period	Early	Peak competition period			Recovery
Specific vs Non-Specific Ratio	20-80		30-70	50-50			70-30		80-20			10-90
Aerobic Capacity	Develop								Maintain			Very low volume; no intensity; physical and mental regener-ation.
Aerobic Power	Maintain		Develop						Maintain			
Anaerobic Alactic Power/ Speed			Develop				Maintain					
Anaerobic Lactic Capacity												
Strength	Develop good strength technique; general prep		Gender specific focus: female athletes can start more intense strength training		Develop power and endurance		Maintain (core and upper body)					
Racing			Off-season races every 3-4 weeks in an endurance sport/activity					Race preparation, adaptation	Peak preparation			
Technique		Aquire new technique and correct mistakes		Stabilize new patterns		Stabilize at high intensity		On snow adaptation	Maintain			
Mental Training	Develop basic/overall skills								Maintain overall skills and determine Ideal Performance State (IPS)			
Medical Assessment	x					x					x	
Monthly Volume (Average Hrs)	20-30	25-35	25-35	30-40	30-40	30-40	40-50	40-50	30-40	30-40	20-30	15

NOTE: Energy system training like aerobic capacity, aerobic power, anaerobic alactic power, etc, should include some sessions of double pole and legs only work.

YTP Guidelines for L2C

For later part of stage: Females 17-19, Males 18-20

= Priority 1 = Priority 2 = Priority 3

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Periods	General preparation period		Specific preparation period			Pre-competition period		Early competition period	Peak competition period			Recovery
Specific vs Non-Specific Ratio	20-80	40-60	40-60		60-40	70-30		70-30	80-20			10-90
Aerobic Capacity	Develop							Maintain	Maintain			Very low volume; no intensity; physical and mental regener-ation.
Aerobic Power	Maintain		Develop					Maintain				
Anaerobic Alactic Power/ Speed	Develop							Maintain				
Anaerobic Lactic Capacity					Develop			Maintain				
Strength	Develop good strength technique; general prep		Develop max stength and hypertrophy		Develop power			Maintain (core and upper body)				
Racing		Off-season races every 3-4 weeks in an endurance sport/activity						Race preparation, adaptation	Peak preparation			
Technique		Aquire new technique and correct mistakes		Stabilize new patterns		Stabilize at high intensity	On-snow adaptation		Maintain			
Mental training	Acquire new techniques and correct undesired patterns			Develop focus and stress management			Maintain all skills					
Medical Assessment	x			x			x			x		
Monthly Volume (Average Hrs)	40-60	50-70	50-60	50-70	50-60	50-70	50-60	40-50	40-50	40-50	30-40	20

NOTE: Energy system training like aerobic capacity, aerobic power, anaerobic alactic power, etc, should include some sessions of double pole and legs only work.

Yearly Training Plan Guidelines – Training to Compete

YTP Guidelines for T2C Females 19-23, Males 20-23

= Priority 1 = Priority 2 = Priority 3

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Periods	General preparation period		Specific preparation period (incl 2-3 on-snow training camps)			Pre-competition period	Early competition period		Peak competition period			Recovery
Specific vs Non-Specific Ratio	20-80	30-70	40-60		60-40	70-30	80-20		80-20			10-90
Aerobic Capacity	Develop						Maintain		Maintain			Very low volume; no intensity; physical and mental regeneration.
Aerobic Power	Maintain		Develop					Maintain				
Anaerobic Alactic Power/ Speed	Develop						Maintain					
Anaerobic Lactic Capacity				Develop			Maintain					
Strength	Develop good strength technique; general prep		Develop max strength and improve individual deficiencies		Develop power		Maintain (core and upper body)					
Racing			Off-season racing once every 2-3 weeks in an endurance sport/activity				Preparation racing		Peak racing			
Technique		Aquire new technique and correct mistakes		Stabilize new patterns		Stabilize at high intensity	On-snow adaptation		Maintain			
Mental training	Acquire new techniques and correct undesired patterns			Develop focus and stress management			Develop racing tactics Maintain other components					
Medical Assessment	x			x			x			x		
Monthly Volume (Average Hrs)	50-60	60-80	60-80	60-80	50-70	50-70	60-80	50-70	50-70	50-60	35-50	30

NOTE: Energy system training like aerobic capacity, aerobic power, anaerobic alactic power, etc, should include some sessions of double pole and legs only work.

YTP Guidelines for T2W 23± and over, Males and Females

= Priority 1 = Priority 2 = Priority 3

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Periods	General preparation period		Specific preparation period (incl 3-4 on-snow training camps)			Pre- competition period	Early competition period		Peak competition period			Recovery
Specific vs Non-Specific Ratio	30-70		50-50	60-40		70-30	80-20		80-20			30-70
Aerobic Capacity	Develop						Maintain		Maintain			Low volume; no intensity; physical and mental regeneration.
Aerobic Power	Maintain		Develop				Maintain					
Anaerobic Alactic Power/ Speed	Develop						Maintain					
Anaerobic Lactic Capacity	Maintain			Develop			Maintain					
Strength	Develop good strength technique; general prep		Individually tailored program to improve deficiencies		Optimize power		Maintain (core and upper body)					
Racing		Off-season racing once every 2-3 weeks in an endurance sport/activity				Preparation racing		Peak racing				
Technique		Individualized focus to improve deficiencies				Stabilize at high intensity	On-snow adaptation		Maintain			
Mental Training	Individualized focus to improve deficiencies						Optimize race tactics Optimize other components					
Medical Assessment	x			x			x			x		
Monthly Volume (Average Hrs)	70-80	70-80	70-90	70-90	60-80	60-80	60-80	50-70	50-70	50-60	40-60	40

NOTE: Energy system training like aerobic capacity, aerobic power, anaerobic alactic power, etc, should include some sessions of double pole and legs only work.

Glossary of Terms

Adaptation refers to a response to a stimulus or a series of stimuli that induces functional and/or morphological changes in the organism. Naturally, the level or degree of adaptation is dependent upon the genetic endowment of an individual.

Adolescence is a difficult period to define in terms of the time of its onset and termination. During this period, most bodily systems become adult both structurally and functionally. Structurally, adolescence begins with acceleration in the rate of growth in stature, which marks the onset of the adolescent growth spurt. The rate of statural growth reaches a peak, begins a slower or decelerative phase and finally terminates with the attainment of adult stature. Functionally, adolescence is usually viewed in terms of sexual maturation, which begins with changes in the neuroendocrine system prior to overt physical changes and terminates with the attainment of mature reproductive function.

Aerobic Capacity (for the purposes of this document) may be thought of as synonymous with aerobic endurance. That is, the ability to perform without decrement in performance over tens of minutes with the energy contribution being almost exclusively aerobic as the time of the effort/performance increases.

Aerobic Power refers to the maximal rate at which the aerobic system can contribute to energy production. Therefore, this will tend to influence maximal effort events or repetitions lasting in the range of two to eight minutes. It should be realized that 'anaerobic' processes are heavily involved in such power outputs/performance levels.

Anaerobic Capacity (following the pattern of terms above) is concerned with the ability of the various anaerobic metabolic pathways (predominantly the anaerobic glycolytic or anaerobic lactate system) to produce high power outputs in the 45 second to two minute range.

Anaerobic Power (for the purposes of this document) emphasizes the ability of the anaerobic glycolytic system to produce high, but short duration (approximately 8 – 45 seconds), power outputs. In addition to this aspect is the ability of the Anaerobic Alactate system (ATP-CP), which is able to utilize immediately available energy stores for explosive and, or, ultimate speed (i.e., 0 – 8 second durations) actions.

Ancillary Capacities refers to the knowledge and experience base of an athlete and includes warm-up and cool-down procedures, stretching, nutrition, hydration, rest, recovery, restoration, regeneration, mental preparation and taper and peak. The more knowledgeable athletes are about these training and performance factors, the more they can enhance their training and performance levels. When athletes reach their genetic potential and physiologically cannot improve anymore, performance can be improved by using the ancillary capacities to full advantage.

Childhood ordinarily spans the end of infancy – the first birthday – to the start of adolescence and is characterized by relatively steady progress in growth and maturation and rapid progress in neuromuscular or motor development. It is often divided into early childhood, which includes pre-school children aged 1 to 5 years, and late childhood, which includes elementary school-age children, age 6 through to the onset of adolescence.

Chronological Age refers to the number of years and days elapsed since birth. Growth, development and maturation operate in a time framework; that is, the child's chronological age. Children of the same chronological age can differ by several years in their level or biological maturation. The integrated nature of growth and maturation is achieved by the interaction of genes, hormones, nutrients and the physical and psychosocial environments in which the individual lives. The complex interaction regulates the child's growth, neuromuscular maturation, sexual maturation and general physical metamorphosis during the first two decades of life.

Developmental Age refers to the interrelationship between growth and maturation in relation to the passage of time. The concept of development also includes the social, emotional, intellectual and motor realms of the child. Developmental age reflects the true overall situation of an individuals growth and maturation and may be thought of as an index of development stated as the age in years of an individual and determined by specified standardized measurements such as motor and mental tests and body measurements. The terms "growth" and "maturation" are often used together and sometimes synonymously. However, each refers to specific biological activities. Growth refers to observable, step-by-step, measurable changes in body size such as height, weight, and percentage of body fat. Maturation refers to qualitative system changes, both structural and functional in nature, in the organism's progress toward maturity; for example, the change of cartilage to bone in the skeleton.

Peak height velocity (PHV) is the maximum rate of growth in stature during the adolescent growth spurt. The age of maximum velocity of growth is called the age at PHV. The rate of change in height varies through specific stages of growth and allows for 'height cues' or rates of growth changes to be used as potential indicators of appropriate programming and evaluation content for developing athletes.

Physical Literacy refers to the mastering of fundamental motor skills and fundamental sport skills.

Post-natal Growth is commonly, although sometimes arbitrarily, divided into three or four age periods, including infancy, childhood, adolescence, and puberty.

Readiness refers to the child's level of growth, maturity, and development, which enables him/her to perform tasks and meet demands through training and competition.

Skeletal Age refers to the maturity of the skeleton determined by the degree of ossification of the bone structure. It is a measure of age that takes into consideration how far given bones have progressed toward maturity, not in size, but with respect to shape and position to one another.

Speed may be thought of as the ability to move a limb, limbs, or the whole body at the greatest possible velocity. In addition, speed involves the capability to react to a stimulus or signal (such as a starting signal, stumble, or fake/deke) in the shortest possible time. Speed may be incorporated as part of physical training and, or, technical training depending upon the stage of development of the athlete or the sport specificity required.

Trainability refers to the genetic endowment of athletes as they respond individually to specific stimuli and adapt to it accordingly. Malina and Bouchard (1991) defined trainability as the responsiveness of developing individuals at different stages of growth and maturation to the training stimulus.

Training Age refers to the age where athletes begin planned, regular, serious involvement in training. The tempo of a child's growth has significant implications for athletic training because children who mature at an early age have a major advantage during the Training to Train stage compared to average or later maturers. However, after all athletes have gone through their growth spurt, it is often later maturers who have greater potential to become top athletes provided they experience quality coaching throughout that period.

Window of Trainability refers to a point in the development of a specific behaviour when experience or training has an optimal effect on development. The same experience, introduced at an earlier or later time, has no effect on or retards later skill acquisition.

Acknowledgements & References

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