Feb. 3, 2015

Competition-Coaching Introduction Advanced (T2T)

Step 2:

Growth and Maturation

Reference Material
for Dryland Workshop

National Coaching Certification Program

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This section on Growth and Maturation expands on the information on developmental age and trainability outlined in section 2 of the Learning to Train (Dryland) Reference Material and is directed at supporting you in your role working with athletes in the Training to Train stage of athlete development.

2.1 Developmental Age

Growth and maturation are two aspects of development that are often confused with each other.

- **Growth** - refers to observable, step-by step, measurable changes in body size such as height, weight and percentage of body fat.
- **Maturation** - refers to more subtle qualitative system changes, both structural and functional in nature, in the body's progress to maturity; for example the change of cartilage to bone in the skeleton.

Development 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.

Developmental age therefore is highly individualistic 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, on the other hand, refers to the number of years and days elapsed since birth.

Keeping these concepts in mind, a coach can identify whether an athlete is an early, average or late maturer in order to design an optimal training and competition program - one that fits the individual's level of maturity.

2.1.1 Early vs Late Developers

Adolescence is the period between childhood and becoming an adult. While both the start and end of this period are difficult to define, it is usually obvious when an individual is going through the many physical, psychological and social changes that accompany it.

Not all children enter adolescence at the same age, and it takes different children different lengths of time to complete the process. In general, children who enter adolescence early pass through it faster than those who start later, and whether they start early or late partially depends on their body shape. Stockier, more muscular children usually enter adolescence earlier than their peers who are thinner and leaner.

The whole process starts at approximately age 10-11 for girls, and approximately two years later for boys. It usually takes 3 to 4 years to complete. This means that for girls aged 12, some will have almost completed the physical changes of puberty, while others have barely started. For boys the greatest range of development is found in 14 year olds.

> One very important advantage late developers have is that they have a longer period of time between learning fundamental movement skills and the onset of adolescence. This "Learning to Train" stage is a time when the human body is perfectly designed for the acquisition and refinement of sport skills, and the longer that children are in this stage, the better developed their skills can become.

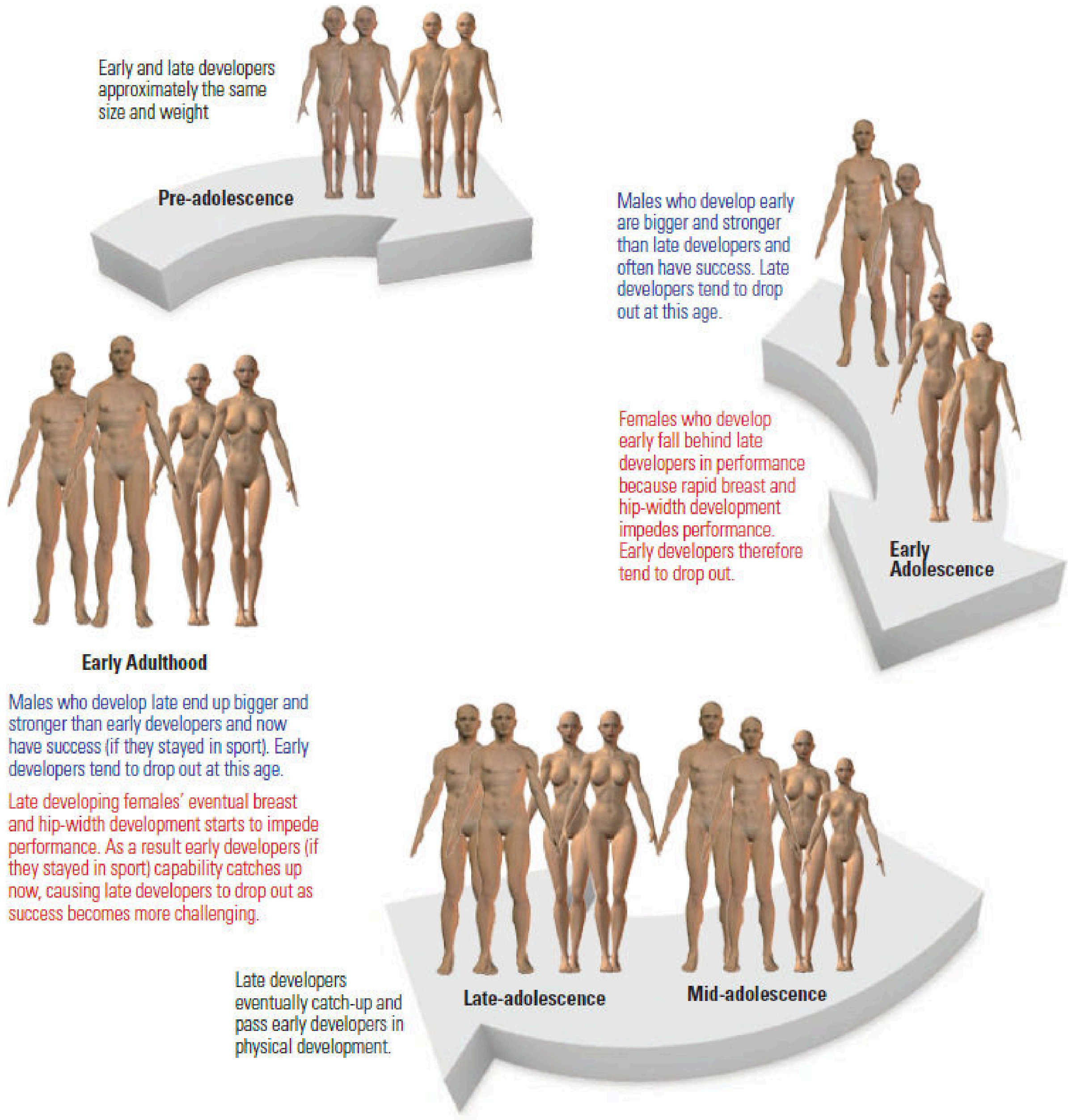
2.1.2 The Challenge for Early and Late Developers

Few sports understand the difficulties faced by early and late developers, and those difficulties are different for boys and girls. Because of this, in many Canadian sports there are disadvantages to being either an early or a late developer.

- **Males**. In reality, male late developers are often at a great disadvantage. This is especially true in sports where age group competitions are held. As their peers go through puberty, late developing males find themselves much smaller, less muscular and physically weaker. Training and competing against bigger, stronger and faster opponents is not always fun, particularly in contact sports, and late developers therefore tend to drop out, despite the fact that in the long run they have greater potential for success. There are also disadvantages to being an early developer, though these take longer to materialize. Early in adolescence, early developers (who go through a relatively rapid but short adolescence) are bigger, stronger and faster than their peers and this often translates into sporting success. However, as late developing competitors go through their longer, more sustained, growth spurt, they eventually catch up with and surpass the early developers. With their late developing peers now bigger, faster, stronger and more skilled than them, the early developers tend to drop out of their sport. This usually occurs towards the end of adolescence.
- **Females**. For females the situation is less clear, but appears to be reversed. Changes to their body along with social pressures to discontinue sport involvement can cause early developers to drop out early in their teen years, while late developing females who had success with their prepubescent bodies when their competitors developed before them, face the same difficulty when older.

Early and late maturing children drop out of sport at different times for different reasons, as explained in the chart below.

Figure 2.1: Characteristics of Early and Late Developers (Developing Physical Literacy Guide, 2008)



2.1.3 Consequences of the Time of Year When a Child is Born

As pointed out earlier, children who are the oldest in their age group tend to be larger, stronger and more skilled than their younger team mates. It is believed that this causes coaches to believe that these athletes are "better" than the younger ones. They seem to pay more attention to and spend more time coaching them – and in the end these advantages tend to make them better athletes with more chance to advance to higher levels in the sport.

Consider for example that in 2007 more that 13% of hockey players who were drafted in major junior hockey were born in January, and only 4% December! This is called the relative age effect.

The relative age effect describes the observation that greater numbers of performers born early in a selection year are over-represented in junior and senior elite teams compared to what might be expected based on national birth rates. It is well documented that relative age is a great advantage in athletic selections.

Figure 2.2 below shows the distribution of birth months of players in three Canadian major ice hockey leagues. The data indicate that the probability of success in high caliber hockey is dramatically reduced for those born at the end of the year. Furthermore, among National Hockey League players who were active in the early 1980s, about 40% were born in the first quarter of the year, 30% the second, 20% in the third and less than 10% in the final quarter.

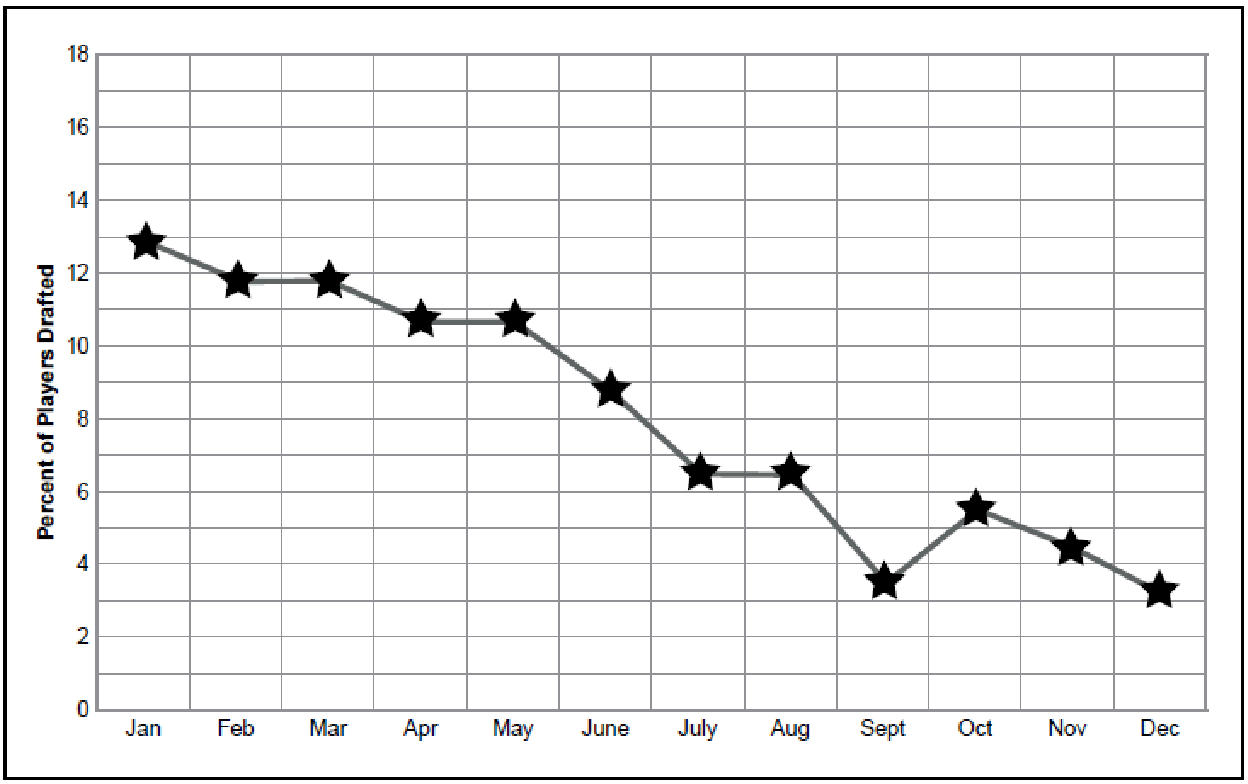


Figure 2.2: Distribution of Birth Months of Drafted Ontario Hockey League, Western Hockey League and Quebec Major Hockey League Players (Barnsley, Thompson and Barnsley, 1985).

It is important for coaches, parents and athletes to recognize the relative age effect. Research has shown that selection to top-tier or representative teams favors athletes born in the first third of the year due to most sports having age cut-off dates based on the calendar year. However research also shows that if athletes with late birthdays have access to good coaching and programming they ultimately succeed at a later age when their development catches up.

> If relative age (which is only a 10-12 month difference) can have such a significant impact on selection, participation and performance, then it is obvious that developmental age (which may be four to five years difference) can have a huge impact. It is therefore essential that coaches, programmers, parents and sport administrators have a good understanding of the maturation process and its consequences and take developmental age-related considerations into account when designing their programs.

2.2 Monitoring Growth and Maturation

When a coach develops a training, competition and recovery program for an athlete, there are a number of ages that need to be considered including:

- Chronological age.
- Developmental age (physical, mental and emotional).
- Skeletal age.
- General training age.
- Sport-specific training age.
- Relative age.

Chronological Age - refers to the number of years and days elapsed since birth. Children of the same chronological age can differ by several years in their level of biological maturation. Athletes of the same chronological age between 10 and 16 can differ by as much as four or five years in their developmental age.

Developmental Age - refers to the degree of physical, mental, cognitive and emotional maturity. Physical developmental age can be determined by skeletal maturity or bone age, after which mental, cognitive and emotional maturity is incorporated.

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 towards maturity - not in size, but with respect to shape and position to one another.

General Training Age - refers to the number of years in training while sampling different sports.

Sport-specific Training Age - refers to the number of years since an athlete decided to specialize in one particular sport.

Relative Age - refers to the differences in age among children born in the same calendar year.

Growth measurements are needed to monitor and identify the maturity level of the athletes, so training, competition and recovery programs will be designed on developmental age and not on chronological age.

2.2.1 Peak Height Velocity

Peak Height Velocity (PHV) is the fastest 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. In this the beginning of the growth spurt and the peak of the growth spurt are very significant considerations. 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 noted above, PHV can be used as a guide to growth and physical maturity during adolescence and it can be used to identify the maximum growth rates of children. In order to track PHV, data must be collected on a longitudinal basis, with the analysis of models and graphs.

2.2.2 Growth Phases

Somatic (musculo-skeletal) growth follows six phases:

Phase 1: Chronological age zero to six. This phase is characterized by very rapid growth during infancy and rapid deceleration after age two. It is recommended that measurement of standing height and weight are carried out every birthday.

Phase 2: Age six to the onset of the growth spurt. This phase is characterized by steady growth (an average of 5-6 cm per year). It is recommended that measurement of standing height, sitting height and arm span are carried out at every birthday. If measurements take place in a club setting, do the first measurement of the year at the beginning of the annual season. Once the onset of PHV is identified, start to take measurements of standing height, sitting height and arm span quarterly (every three months).

During this phase the sensitive periods for skill, speed and suppleness should be identified by chronological age.

Phase 3: From the onset of the growth spurt to PHV. This phase is characterized by rapid growth. In the first year the average growth is seven centimeters. In the second year it is approximately nine centimeters for boys and 6-8 cm for girls. It is recommended that measurements of standing height, sitting height and arm span are recorded quarterly in order to monitor which part of the body is growing the fastest. The change in the centre of gravity, leg and arm span will help coaches to understand the process better (for example, the athlete is losing coordination and speed due to rapid growth).

During this phase the aerobic capacity window should be identified by the onset of PHV and the second speed window by chronological age.

Phase 4: From PHV to slow deceleration of growth. This phase is characterized by rapid deceleration. In the first year after peak growth boys will grow approximately seven centimeters, and girls six centimeters. In the second year they will both grow approximately three centimeters. It is recommended that measurements of standing height, sitting height and arm span are taken quarterly to monitor deceleration.

During this phase the sensitive period for aerobic power and strength can be identified after deceleration as described in section 2.4.1. That is to say, aerobic power should be trained after PHV of PHV. In terms of females, strength training can be prioritized immediately after PHV or at the very onset of menarche. For males, strength training should be a priority 12-18 months after PHV (Ross & Marfell-Jones, 1991; Beunen & Thomis, 2000; Anderson & Bernhardt, 1998).

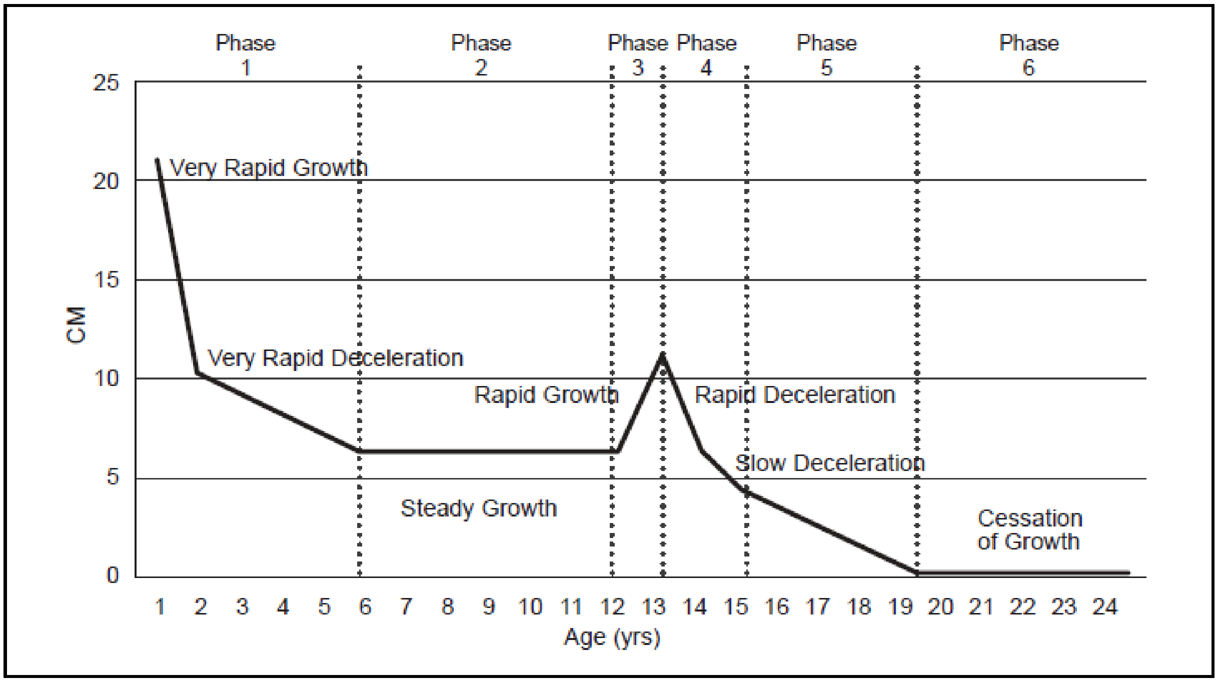
Phase 5: From slow deceleration of growth to cessation of growth. Slow deceleration will start one to two years after PHV and will end with cessation of growth.

It is recommended that training loads and intensities be determined gradually by diagnostics. Since all systems are now fully trainable, testing will identify individual and team training priorities.

Phase 6: Cessation of growth. During this phase it is recommended that the individual diagnostics of the strengths and weaknesses of the athlete determine training loads and intensities.

The biological markers of the onset of PHV and the onset of menarche monitored by the measurements described in this section should allow coaches to optimize training for the pubescent athlete by using the opportunities provided by sensitive periods of trainability.

Figure 2.3: Phases of growth



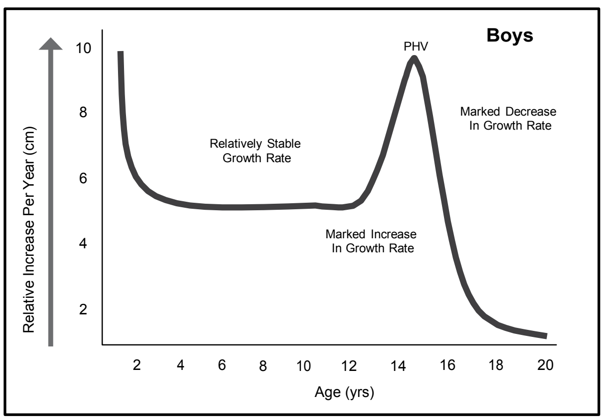


Figure 2.4: Rate of Change in Height & Peak Velocity (PHV) (Adapted from Tanner, 1978 & Kahn, 1999)

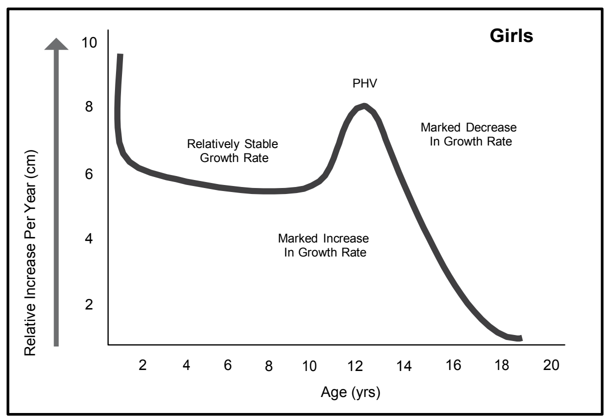


Figure 2.5: Rate of Change in Height & Peak Velocity (PHV) (Adapted from Tanner, 1978 & Kahn, 1999)

2.2.3 How to Measure PHV

Tools and Equipment

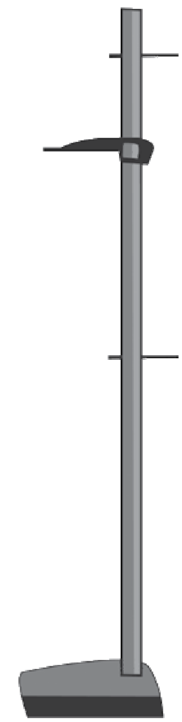
When considering the equipment needed for measurement, one must look at how much emphasis is going to be put on the measurement of stature. If stature data is going to be heavily incorporated into training plans, data must be very accurate, and, if that is the case, higher quality equipment will be needed.

❏ **Ideal Equipment**

A free standing or wall mounted stadiometre.

✓ The stadiometre would have sliding headboards and a dial or digital read-outs which would aid the ease of use.

Figure 2.6: Stadiometre



❏ **Acceptable Equipment**

✓ An anthropometre or retractable steel measuring tape.
✓ A headboard.
✓ A smooth floor with a straight flat wall at 90 degrees.

❏ **Unacceptable Equipment**

✓ A cloth measuring tape.
✓ Flexible material.
✓ Carpeted floor.
✓ An uneven floor.
✓ No backboard.

Why Measurement Accuracy is So Important?

It is extremely important to use proper technique when measuring an athlete, as the more errors there are, the harder it will be to interpret the results, and the less value the results will have. To decrease error, ensure the following:

❏ the environment is consistent and controlled;

❏ clothing is consistent and not bulky;

❏ you have the cooperation of the athlete; and

❏ you follow standardized and consistent procedures.

What to Measure?

Determining the rate of growth is dependent on taking accurate measurements. Therefore measurements need to be made to the nearest 0.1 cm. Each athlete should be measured and recorded twice, but these measurements should not differ by more than 0.4 cm. If they do not differ by more than 0.4 cm, the mean of the two measurements should be taken. If they do differ by more than 1.4 cm, a third measurement should be taken, and the median of all three measurements should be calculated.

❏ **Example #1:** Two measurements within 0.4 cm of each other:

✓ Stature measurement #1 – 166.2 cm.
✓ Stature measurement #2 – 166.3 cm.

- ✓ The above two measurements are within the acceptable range and the mean measurement recorded as 166.3 cm.

- ❑ **Example #2:** Two measurements not within 0.4 cm of each other:
  - ✓ Stature measurement #1 – 158.2 cm.
  - ✓ Stature measurement #2 – 162.9 cm.
  - ✓ Stature measurement #3 – 162.6 cm.
  - ✓ The first two measurements are not within 0.4 cm of each other. Therefore the median of the three scores needs to be used and the recorded score will be 162.6 cm.

For detailed information on the protocols for measuring growth refer to end of this section.

When to Measure

For several reasons it is important that coaches do not become obsessed with the number of times height is recorded:

- ❑ The athletes may become bored.
- ❑ The athletes may become preoccupied with measurements, particularly if they perceive they are not growing as fast as their peers.
- ❑ Intervals between testing periods need to be long enough to allow for substantial growth over and above what would be expected to occur through measurement error (Williams, 2009a).

It is recommended that:

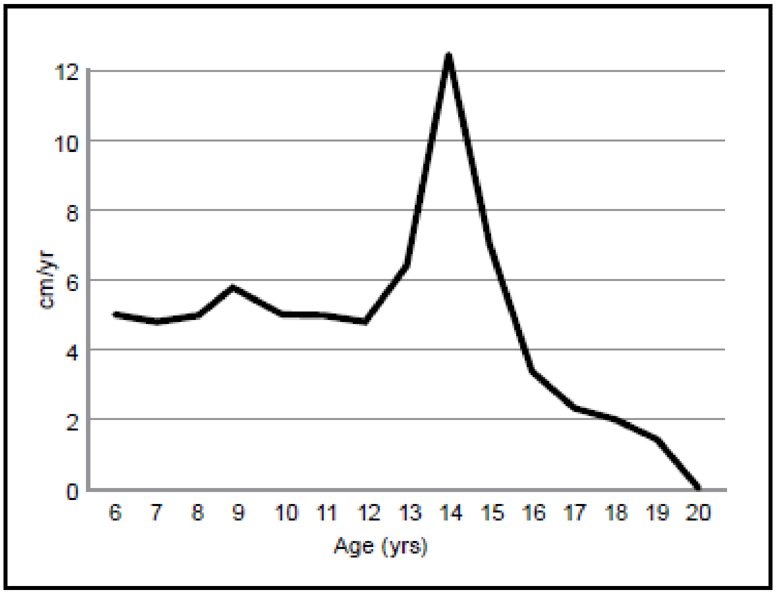
- ❑ Measurements are made once quarterly.
- ❑ Measurements are made as close as possible to the same date in the month, and also the same day.
- ❑ Part of a training session be set aside for measurements.
- ❑ Measurements are taken after a day of rest. This will ensure there are no confounding effects of training from the previous day.
- ❑ Measurements are taken at the beginning of the training session as the athlete will not be prone to any effects from the training session (stretching, bouncing, drop jumps, etc. can all have an impact on stature (Williams, 2009a).

Even if the coach thinks the athlete has started his/her pubertal growth spurt, the serial measurements, taken over a year, will determine if the athlete is past the stage of PHV. The earlier the measurements can occur, prior to the growth spurt, the greater the opportunities are or the coach to adjust the training program according to the growth rate. As PHV occurs typically at 12 years for females and 14 years for males, it would be beneficial to have as many measurement points as possible prior to this age.

Figure 2.7: Typical Growth Starting at Age Five

Year	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ht (cm)	5.0	4.8	5.0	48	5.0	4.8	8.6	12.0	7.7	3.3	2.3	1.9	1.3	0.9	0.5

Figure 2.8: The Rate of Growth or "Growth Velocity Curve" of a Boy Based on Table 1 (Charted from 6-20 Years of Age)



How to Measure

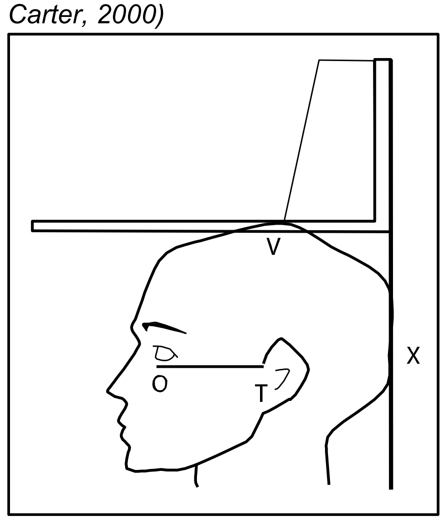
When measuring a child's height, it is important to pay careful attention to the technique used so that the results will be meaningful. Ideally two measurers should be present, one to perform the positioning of the athlete and one to record the actual measurement. If a second measurer is not available, it is still possible to get valid results, but to do so extra attention needs to be given to the technique.

For proper measurement of height refer to Figure 2.9.

Measuring can be accurate if the athlete's head is level. Proper Measuring = Measuring Height

The orbitale (O) is located on the lower or most inferior margin of the eye socket. The tragion (T) is the notch above or superior to the tragus or flap of the ear, at the superior aspect of the zygomatic bone. This position corresponds almost exactly to the visual axis when the subject is looking directly ahead.

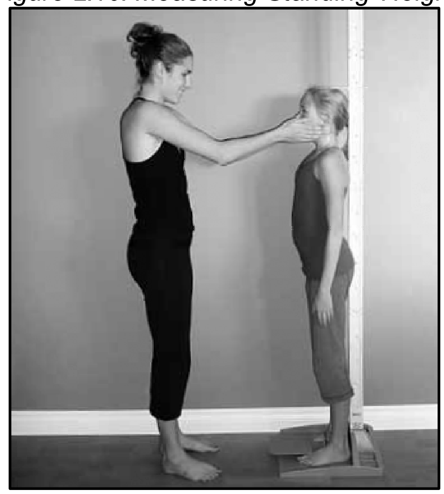
Figure 2.9: Orientation of the Head in the Frankfort Plane(Ross, Carr & Carter, 2000)



Protocol for Standing Height Measurement

- The athlete should stand erect in bare feet with heels, buttocks and shoulders pressed against the stadiometre.
- The heels should be together; the arms should be hanging freely by the athlete's' side; the palms of the hands should be facing the thighs.
- The athlete should look straight ahead, take a deep breath and stand as tall as possible.
- The tester then applies gentle upward traction to the athlete's skull, behind the ears, to ensure the trunk is fully stretched.
- The tester/assistant draws down the measuring bar to the athlete's head and records the standing height to the nearest 0.1 cm.

Figure 2.10: Measuring Standing Height



Protocol for Sitting Height Measurement

- The athlete should sit on the base of the stadiometre, with knees slightly bent. The hands should rest on the knees.
- The buttocks and shoulders should rest lightly against the stadiometre, which should be positioned vertically behind the athlete. The tester needs to ensure that there isn't a gap between the buttocks of the athlete and the stadiometre.
- The tester then applies gentle upwards traction to the athlete's skull, behind the ears, to ensure the trunk is fully stretched.
- The tester/assistant draws down the measuring bar to the athlete's head and records sitting height to the nearest 0.1 cm.
- Once sitting height is calculated, it can be subtracted from the stature score in order to derive the leg length height.

Figure 2.11: Measuring Sitting Height

Protocol for Arm Span Measurement

- The first step is to mount the tape measure on the wall at the approximate height of the shoulders of the athletes being tested. The tester/assistant must ensure that the starting point of the tape measure is fixed to a corner of the wall. This is where the athlete's fingers must be fixed.
- The athlete should stand erect with stomach and toes facing the wall, feet together and head turned to the right.
- The arms should be extended laterally at shoulder level (horizontal) with the palms of the hands facing forwards (towards the wall). The fingers should be stretched out.
- The tip of the athlete's middle finger should be aligned with the beginning of the tape measure (corner of wall) and the arms should be outstretched along the tape measure.
- The tester/assistant then uses a ruler held vertically to the tape measure to record total arm span to the nearest 0.1 cm.

Figure 2.12: Measuring Arm Span

It is important to be aware of the ethical and sensitivity issues surrounding the measurement and monitoring of an athlete's development. Coaches should not only understand the physical changes to a child's shape and size, but also the implications these changes can have on their personality and their perception of their body (as well as other people's perception of their body).

Coaches are in a unique position to offer good advice and educate their athletes in a sensitive and appropriate manner.

Determining a Velocity Curve

To determine a velocity curve, the increase in stature from one measurement time period to the next consecutive measurement time period is subtracted one from the other. For example, from nine years to 10 years the increase in stature is 5.0 cm. By plotting the velocity curves it will be possible to clearly distinguish the rate of growth from one time point to another. The velocity curve will immediately show distinctive growth points - for example the onset of the acceleration in the curve, the peak of the curve and the deceleration of the curve.

2.2.4 Tables for Plotting Annual and Quarterly Growth

Chart 1: Standing Height Measurements Chart – Example (see below for corresponding Chart 3 for plotting velocity curve)

Age	9	10	11				12				13				14			
Growth in cm	5	6	0.9	1.3	3	1	1.5	3	2.6	1.5	2	5	3	2	1.5	2.7	2	1.5
Total Growth in cm	5	6	6.2				8.6				12				7.7			

15				16				17				18				19				20			
1.6	2.1	2.0	1.6	1.2	0.7	0.9	1.0	1.1	0.5	0.6	1.0	0.7	0.3	0.5	0.5	0.0	0.4	0.4	0.0	0.0	0.0	0.5	0.0
7.00				4.00				3.2				2.1				0.8				0.5			

Chart 2: Standing Height Measurements Chart – Blank

Age	9	10	11				12				13				14			
Growth in cm																		
Total Growth in cm																		

15				16				17				18				19				20			

Chart 3: Plotting the Growth Velocity Curve for Standing Height - Example (see previous page for corresponding Chart 1 for measuring standing height)

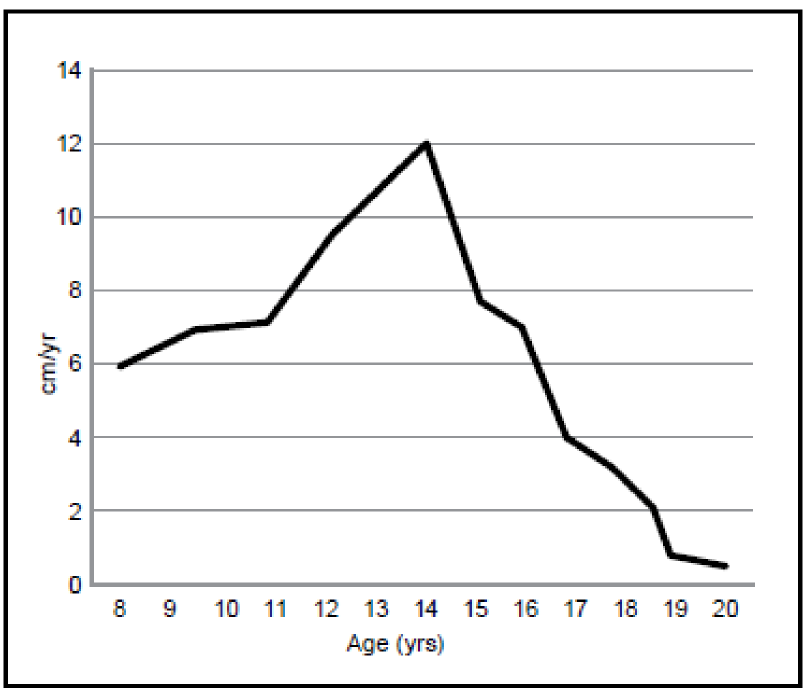


Chart #4: Plotting the Growth Velocity Curve for Standing Height - Blank

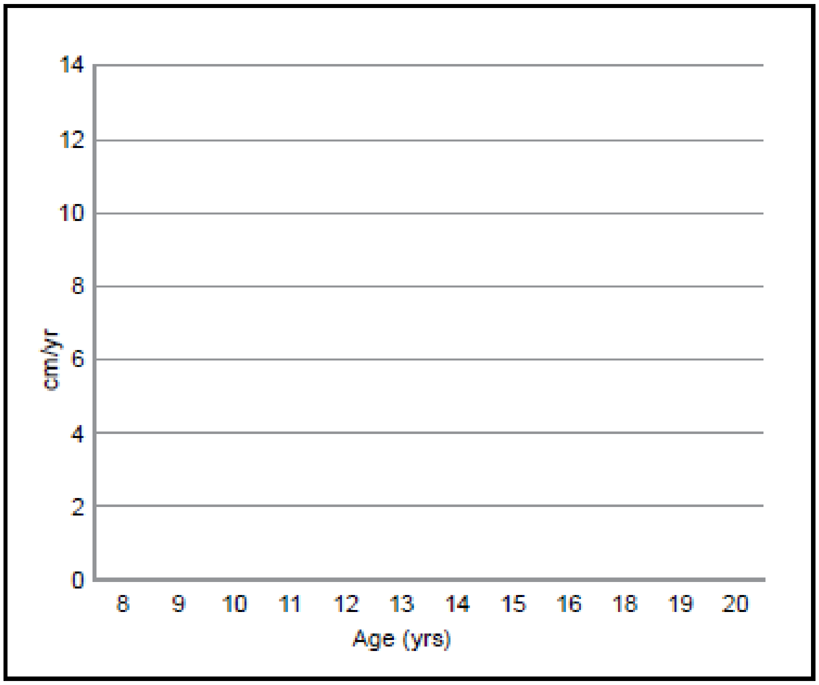


Chart 5: Sitting Height Measurements Chart – Blank

Age	9	10	11	12	13	14	15	16	17	18	19	20
Growth in cm												
Total Growth in cm												

Chart 6: Plotting the Growth Velocity Curve for Sitting Height - Blank

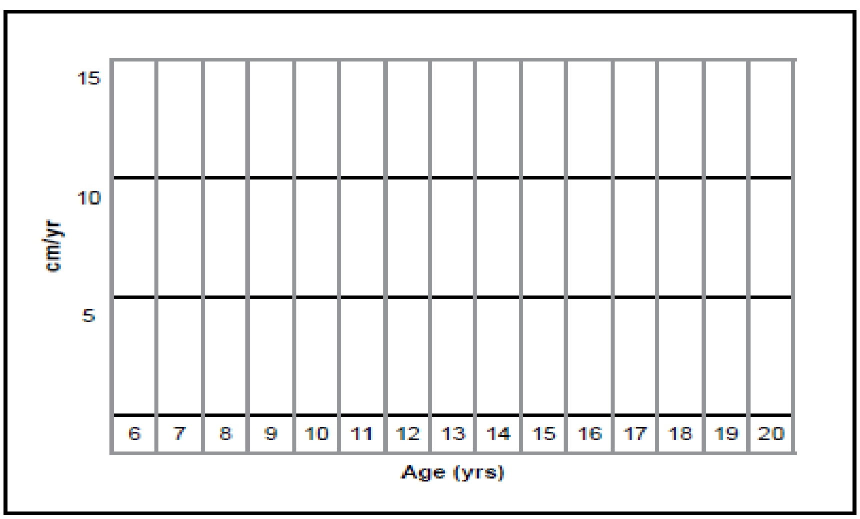
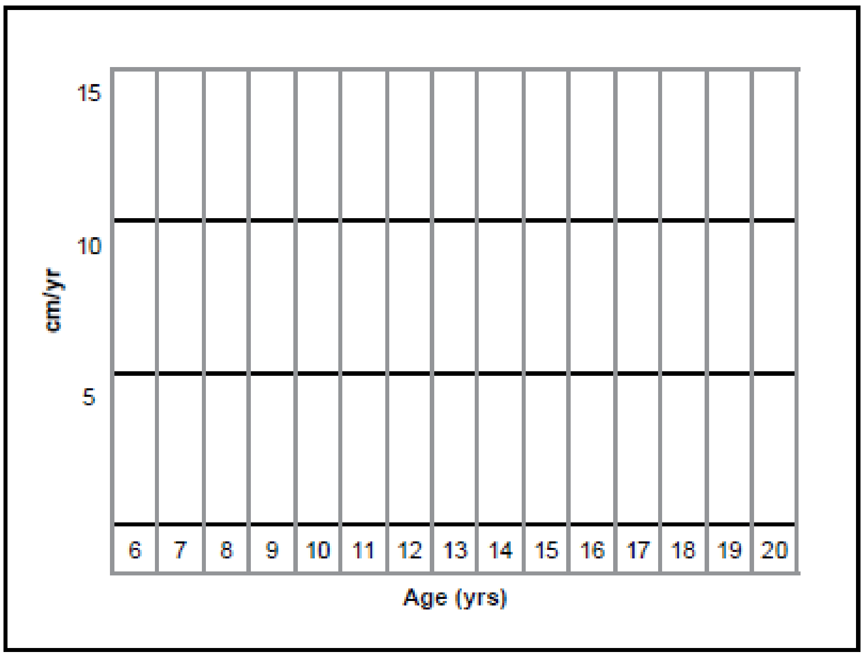


Chart 7: Arm Span Measurements Chart – Blank

Age	9	10	11	12	13	14	15	16	17	18	19	20
Growth in cm												
Total Growth in cm												

Chart 8: Plotting the Growth Velocity Curve for Arm Span - Blank



In Summary:

Monitoring growth before, during and after the adolescent growth spurt is very important for creating individualized plans to optimize athletes' development.

- Growth measurements are needed in order to monitor growth.
- The onset of PHV, PHV and the onset of menarche should be determined so that coaches can adjust training, competition and recovery programs according to the tempo of growth.
- Plotting growth will help to identify the onset of the growth spurt as well as the peak of the growth spurt.
- The onset of menarche is approximately one year after growth decelerates, therefore a coach can estimate when this will take place.

- Standing height should be measured on each birthday (or at the beginning of the ski club's annual training cycle) until the onset of the growth spurt.
- Standing height, sitting height and arm span should be measured quarterly after the onset of the growth spurt.
- The training of skill, speed and flexibility should be based on chronological age, while the training of stamina and strength should be based on the adolescent growth spurt.

2.3 Trainability

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

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.

2.3.1 Windows of Optimal Trainability

Accordingly, periods of sensitivity to particular emphases of training, the so-called "windows of trainability" in the table below, 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.

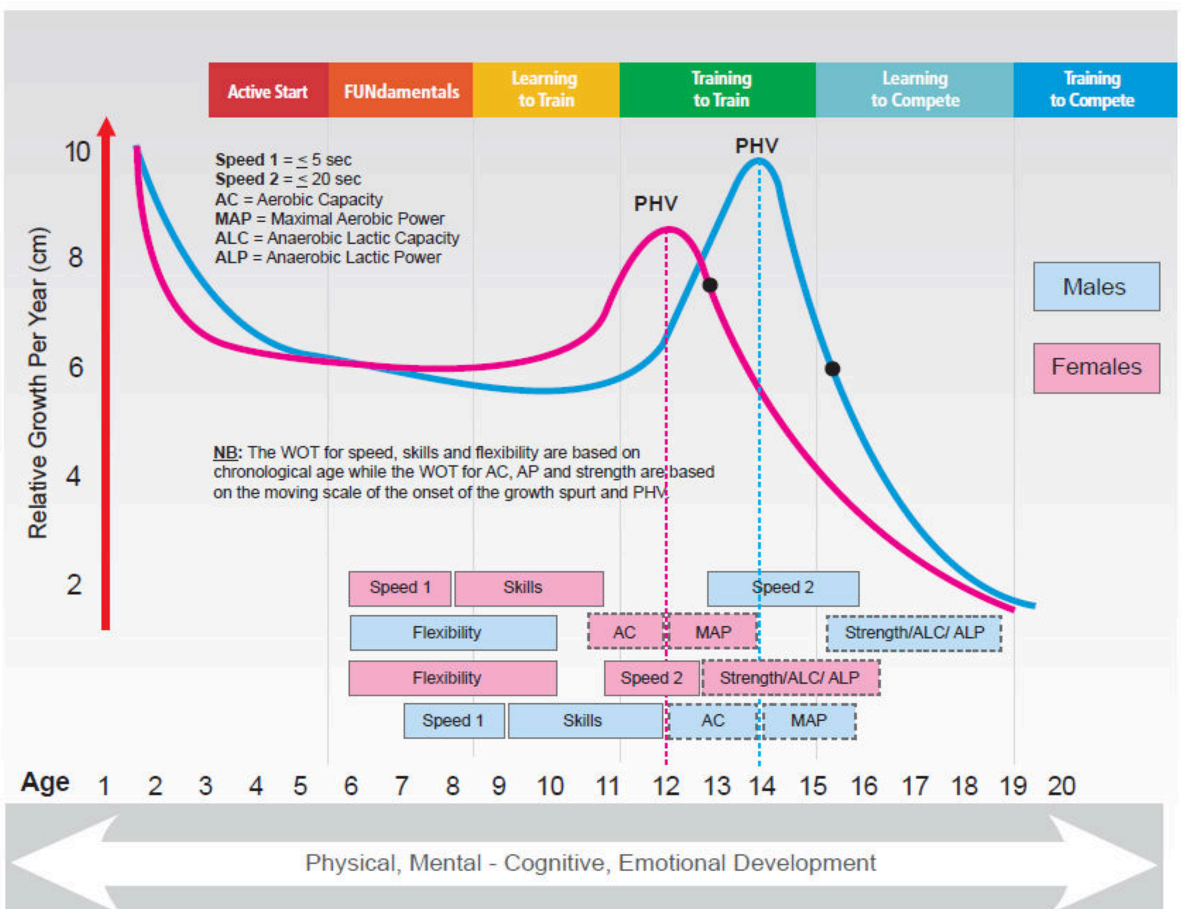


Figure 2.13: Pacific Sport Windows of Optimal Trainability (adapted from Balyi and Way, 2005)

2.3.2 Five Basic S's of Training and Performance

The five S's of training and performance are used as a template to describe the windows of trainability. The trainability of speed, skill and suppleness is based on chronological age; however the trainability of strength and stamina is based on developmental age (the moving scales of the individual tempo of maturation). The trainability of these important S's will require different training programs designed for early, average and late maturers. Such programs should "react" to the individual tempo of maturation. By identifying the tempo of growth through metric measurements, training, competition and recovery programs can be adjusted to individual needs. Aerobic emphasis should begin at the onset of PHV (sport-specific requirements will define if it is a minor or major emphasis), while the beginning of maximal strength training should begin after PHV (Ross & Marfell-Jones, 1991; Beunen & Homis, 2000; Balyi & Ross, 2009a; Balyi & Ross, 2009b). Therefore the technique of measuring growth is very important and should be well defined with a protocol which is simple and reliable to ensure coaches and parents can do the monitoring.

- **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.

2.3.3 Advanced Knowledge – Five Additional S's of Training

- **Structure (Stature).** The structure/stature component links the six stages of growth to the widows of optimal trainability. Coaches and parents can use stature measurements (i.e. height) before, during and after maturation as a guide for tracking developmental age. Such tracking then allows coaches to address the critical or sensitive periods of physical development. Diagnostics for identifying strengths and weaknesses are critical for properly considering structure and stature in the design of training plans.
- **(p)Sychology.** Sport is a physical and mental challenge. The ability to maintain high levels of concentration while remaining relaxed and confident is a skill that

transcends sport and enhances everyday life. To develop the mental focus for success at high levels, young athletes need mental training that complements their physical training, designed specifically for their gender and stage of development. Even at young ages, mental training is critical since dealing with success and failure impacts children's continuation in sport and physical activity.

- **Sustenance.** When the body performs physical activity, it must be replenished with a broad range of components. Sustenance prepares athletes for the volume and intensity required to optimize training and live life to the fullest. Sustenance includes nutrition, hydration, rest, sleep and regeneration – all of which need to be applied differently to training and lifestyle plans depending on the LTAD stage. In managing sustenance and recovery, parents can assist coaches by identifying fatigue. Fatigue can come in many forms, including metabolic, neurological, psychological, environmental and travel fatigue. While overtraining or over- competition can lead to burnout, improperly addressing sustenance can lead to the same result.

- **Schooling.** In designing training programs, school demands must also be considered. Programs should account for school academic loads, timing of exams and school-based physical activities. When possible, training camps and competition tours should complement, not conflict with, the timing of major academic events at school. Stress should be monitored carefully, including the everyday stresses related to schooling, exams, peer groups, family, boyfriend or girlfriend relationships and increased training volume and intensities. Coaches and parents should work together to establish a good balance between all factors.

- **Socio-Cultural.** Sport and physical activities often present athletes with social and cultural experiences that can enhance their holistic development. These experiences can broaden their socio-cultural perspective by providing increased awareness of:

  - ✓ Ethnicity
  - ✓ Diversity
  - ✓ History
  - ✓ Geography
  - ✓ Architecture
  - ✓ Cuisine
  - ✓ Literature
  - ✓ Music
  - ✓ Visual Art

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