Long Term Athletic Development

LTAD is a process or model that allows for optimal physical, psychological, emotional, cognitive and bio motor development of a child or adolescent. It is achieved through the delivery a well-planned long term training programme which should take into consideration the different stages of development and maturation of each individual athlete. The LTAD programme should be based around the following principles:

- Focus on developing the appropriate movement or fitness qualities, throughout the different stages of the development or maturation process.
- Avoidance of early specialisation through just playing one sport.
- Clear, precise and logical progressions throughout the training process in line with the maturation process.
- Continuous monitoring and assessment of both general and athletic development through appropriate screening and testing methods.
- Improve movement qualities and patterns before applying overload to young immature athletes.
- Minimise / Reduce the risk of training and growth related injuries through effective monitoring and training load management.
- Long term not short term, overall improvement of athletic capabilities.

The LTAD model can be split into five or six distinct phases in line with a child’s maturation & development. These phases are identified in fig 25 and includes:

1. Active Start
2. Fundamentals
3. Learning to train
4. Training to train
5. Training to compete
6. Training / competing to win

Each of these phases clearly has different goals and therefore the type of training within each phase will be different as the training should be clearly directed to desired outcomes and training goals of each particular phase.
Active Start Stage

From ages 0-6 years, children need to be introduced to unstructured active play that incorporates a variety of body movements. Children this age need to develop the ABCs of movement; Agility, Balance, Coordination and Speed. The ABCs are essential for developing fundamental movement skills, which will later provide the foundation for fundamental sport skills. Together fundamental movement skills and fundamental sport skills form the basis of physical literacy. An early active start enhances development of brain function, physical coordination, gross motor skills, posture and balance. An active start also helps children to build confidence, social skills, emotional control, and imagination. Children in the active start stage should see physical activity as a fun and exciting part of everyday life. Young children need regular physical activity (active play) to develop and grow properly. A physically active lifestyle is crucial for life-long health and physical and emotional wellbeing.

Physical activity means taking part in active play that uses the body's large muscles. Children should get outside when possible and should experience a range of activities and games.

This activity doesn't always have to be structured, but it should be vigorous. Physical activity should begin during the infancy stage, using toys to prompt movement. It is recommended that children under six shouldn't be inactive for more than 60 minutes at a time (unless sleeping). Reducing screen
time will help keep this schedule intact. Because children need to develop a range of body control, locomotors and sending and receiving skills, it's imperative that they experience a variety of different activities throughout this stage.

Fundamentals Stage

The Fundamental stage is the second of the three LTAD stages that are critical to the development of physical literacy and takes place between the ages of 6-9 in boys and 6-8 in girls. If children fail to develop physical literacy prior to the growth spurt in puberty, they will have limited ability to develop sport-specific skills at older ages and stages of training and development. Obviously, this will significantly impact their desire to continue in lifelong physical activity and limit their opportunities to develop as an athlete. Children in the Fundamental stage are motivated primarily by the desire to have FUN. While they may participate in competitive sports where points are scored, they should be far less concerned with competitive results than they are with having fun, being with friends and developing a strong self-esteem. Children in the Fundamental stage should improve their fundamental movement skills through well-structured programmes and Skill development should happen through a combination of unstructured play in safe and challenging environments and quality instruction from knowledgeable teachers and coaches in structured programmes at their schools or external sports clubs. Children this age should not specialise in a single sport, unless they are participating in one of the few recognised early-specialisation sports (e.g. gymnastics). If they have a preferred sport, they should take part in it two or three times a week, but they should also participate in other sports and physical activities at least three to four times per week. Children this age should develop a strong sense of what is fair and should be introduced to the simple rules and ethics of different sports. Basic rules, tactics, decision making and ethics of sport can also be introduced throughout this phase. Table 38 highlights the different physiological changes that occur during this phase and how to plan the training programme based around these changes.

Principles of the Fundamentals stage

Table 38

<table>
<thead>
<tr>
<th>Growth &amp; Maturation</th>
<th>Training</th>
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</thead>
<tbody>
<tr>
<td>The child is more skillful in gross movements involving large muscle groups than in precise coordinated movements involving the interaction of many smaller muscles.</td>
<td>General basic skill should be developed during this phase</td>
</tr>
<tr>
<td>The size of the heart is increasing in relation to the rest of the body. The cardiovascular system is still developing</td>
<td>Short duration anaerobic activities (alactic) must be planned; Endurance must be developed through play and games</td>
</tr>
<tr>
<td>Ligamentous structures are becoming stronger; Both ends of the long bones are still cartilaginous and continue to ossify.</td>
<td>Slow progression in hopping, jumping, own bodyweight and medicine ball exercises. Volumes and intensity kept low.</td>
</tr>
<tr>
<td>Basic motor patterns become more refined towards the end of this stage. The balance mechanism of the inner ear gradually matures.</td>
<td>Specific activities and games should emphasise coordination. Kinaesthetic sense emphasised in gymnastics, diving, athletics field events.</td>
</tr>
<tr>
<td>During this stage girls develop coordination skills faster than boys but generally there is little difference between the two sexes.</td>
<td>Training and playing together should be emphasised at this stage.</td>
</tr>
</tbody>
</table>
**Key considerations during the Fundamentals stage include:**

- Hand and foot speed can be developed especially well by boys and girls during this stage. If this sensitive period of accelerated adaptation to develop speed is missed, body speed later in life may be significantly compromised.
- This is a great age for children to take part in a wide range of sports. They should be encouraged to take part in as many different types of activities as possible.
- It is important that all children master fundamental movement skills before sport specific skills are introduced.
- Strength, endurance and flexibility need to be developed, but through games and fun activities rather than a training regimen.
- Children need to learn to read the movements going on around them and make sound decisions during games.

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**Learn to Train Stage**

During the learning to train stage which occurs between the ages 8-11 in girls and 9-12 in boys, children should be converting their fundamental movement skills into fundamental sport skills. This stage is defined as the golden age of learning for specific sport skills. The Learn to train stage of LTAD is the most important stage for the development of sport-specific skills. This stage represents a sensitive period of accelerated adaptation to skills training and fine motor control. It is also a time when they should enjoy practicing their skills and seeing their own improvement. The learn to train stage ends when the growth spurt begins. The growth spurt disrupts coordination and motor control, making it more difficult to pick up and develop new sport skills. It is still too early for specialisation in many sports, although many children at this age may have developed a preference for one sport. To maximise the long-term development of their athletic capabilities, they need to engage in a broad range of activities, playing at least 2-3 different sports through the year. While most children naturally enjoy healthy competition, skills training and practice should be the focus at Learn to train (not on winning). It is recommended that approximately 70% of time in the sport should be spent in practice, and no more than 30% of time spent competing in formal games and competitions. (Competitive training activities count as part of the 70% training time). This is the time to develop and refine all fundamental movement skills and learn overall sport skills. The brain is approaching adult size and complexity, and refined skill performance is easier to develop. During this stage children will develop at their own rate and some much faster than others. Children that hit puberty at a slower rate than expected are generally termed as “late developers”. Late developers do have an advantage when it comes to learning skills, as the learn to train stage lasts longer for them. They can often become better sport performers in the long term because of the longer period of skill development that they enjoy. Although conversely, early developers often get selected over the late developers because of the emphasis that coaches and parents often put on competition outcomes at youth level. It is important that schools and clubs provide the late developers with an equal opportunity to train and develop within the sport, so that they do not get overlooked or excluded in the development of the larger pool of future athlete talent.

By this stage, children have developed clear ideas about the sports they like. Their enthusiasm and personal sense of success should be encouraged. The focus should be on playing at least 2-3 sports in
different seasons through the year. Children should not focus only on one sport for an entire year. This is also an important time to start to work on training mobility, endurance and strength mainly through the use of specific games, relays, and own-body weight exercises as opposed to more formalised physical training, although for the more physically and technically developed children early strength training can begin to be implemented.

**Key considerations during the learn to train stage include:**

- Training should provide positive experiences with a deal of enjoyment and fun which should be informal and without regimentation.
- Agility, balance, co-ordination, speed and general strength & stability should be trained through simple bodyweight exercises (movement education, basic gymnastics), games and relays.
- Early speed and agility windows are available for female’s 6-8 years and males 7-9 years old.
- Develop running, jumping, throwing, catching, passing and kicking skills.
- Training intensity & volumes should be kept relatively low to avoid growth related overuse injuries.
- Young athletes must be carefully monitored throughout this period to detect early changes in growth and maturation.

**Train to Train Stage**

During the train to train stage (females 11-15, males 12-16), young athletes need to build an aerobic base and consolidate their sport-specific skills. Towards the end of the stage, they need to focus on both strength development and the anaerobic alactic energy system. Increased training hours are needed at this stage to develop each athlete’s long-term potential. The ages that define the train to train stage are based on the approximate onset and end of the adolescent growth spurt. This period is generally defined as ages 11 to 15 years for females and 12 to 16 years for males. At this stage, athletes are ready to consolidate their basic sport-specific skills and tactics. It is also a major fitness development stage and it is suggested that the train to train stage makes or breaks the developing athlete. Youth athletes may exhibit special talent and want to play to win and to do their best, but they still need to allocate more time to training skills and physical capacities than competing in formal settings. To maximise their long-term potential, winning should remain a secondary emphasis. This approach is critical to the long-term development of top performers and lifelong participants by ensuring their programme is following the correct training-to-competition ratio, along with other guidelines that describe training design and competition objectives at each LTAD stage, coaches should also refer the sport-specific LTAD plan from their sport’s national organisation.

It must be considered that during the train to train stage of LTAD, physical changes take place faster in the athlete than at younger ages. Training programmes need to be designed to account for these rapid changes and the various advantages and disadvantages that they create for the athlete’s development. Therefore, young athletes must be constantly monitored in order to understand how their growth and
maturation is affecting their training and vice versa. During the train to train stage, athletes are entering their growth spurt and passing through puberty. As they do so, their growth can be measured and plotted to calculate the time when they reach peak height velocity (PHV). PHV is an important marker for determining which physical capacities can be trained effectively and safely during this stage. For example, aerobic training should be a priority after reaching PHV.

During the growth spurt, especially if the growth spurt happens quickly, athlete skills and movement abilities may be significantly impeded. Coaches may need to explain to the athletes why their motor skills and movement abilities have been negatively affected, so the athletes can understand that this is a natural event that will pass with time. The training programme should include both flexibility and mobility training to accommodate the rapid growth of bones, tendons, ligaments, and muscles. It should also address the sensitive periods of accelerated adaptation to strength training. For boys, the sensitive period for strength begins 12 to 18 months after PHV.

For girls, the sensitive period begins with whichever of the following occurs first in the individual: menarche or the onset of Peak Weight Velocity (PWV). Some girls will experience PWV prior to menarche, while others will experience menarche prior to PWV. Both aerobic and strength trainability are dependent on the maturation of the athlete. For this reason, the timing of training emphasis may differ between athletes depending on whether they are early, average, or late developers.

Athletes also need to learn to cope with the physical and mental challenges of competition during this stage. Optimal training and competition ratios follow a 60:40 percent training to competition ratio as still too much competition wastes valuable training time; too little competition reduces the practical application and development of technique, tactics, and decision-making skills under realistic competition conditions. Table 39 illustrates the physical changes that occur during this stage and the training considerations that should be applied to maximise the adaptations, whilst minimising the risk of injury.

Table 39

<table>
<thead>
<tr>
<th>Growth &amp; Maturation</th>
<th>Training</th>
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<tbody>
<tr>
<td>Significant proportional changes occur in bone, muscle and fat tissue.</td>
<td>Monitor training carefully and individualise the content of training to ensure adaptation whilst minimising the risk of overuse injuries such as fractures and growth plate injuries.</td>
</tr>
<tr>
<td>Girls begin their growth spurt between 11-14 years, boys between 12-15 years. Girls achieve a maximum rate of grow that an average age of 11, boys at an average of 14 years.</td>
<td>Early in this phase girls maybe faster and stronger than boys; later in the phase boys begin to get the upper hand in these qualities. Chronological age may not be the most appropriate way to group young athletes.</td>
</tr>
<tr>
<td>Smaller muscle groups are becoming more developed. Speed, agility and coordination are still improving rapidly at this stage.</td>
<td>With the improvement of fine motor movement all basic technical skills should be mastered. Athletes must learn how to train during this period including physical, technical, tactical and ancillary capacities.</td>
</tr>
<tr>
<td>A significant increase in red blood cells occurs during this stage, especially in boys due testosterone. The oxygen transport system is still developing and aerobic endurance continues to increase.</td>
<td>The increase in body mass requires more structured aerobic training. Only short duration of anaerobic activities are recommended.</td>
</tr>
</tbody>
</table>
**Key considerations during the train to train stage include:**

- A long training period (6-9 months) and short competition period (2-3 months) is recommended during this stage.
- A greater emphasis on sport-specific skills, although it should still be fun and enjoyable. Also, team sport position-specific skills are introduced without specialization.
- Skill trainability gradually declines after 11 and 12 years of age. It is suggested that the female window is between 8 – 11 years old and the male window is between 9 – 12 years old.
- During this stage, there is a second window for speed & agility development.
- There should be a greater emphasis on strength and endurance training during this stage, especially after PHV has been achieved.
- Emphasis should be on learning how to train, on the process, not on the outcome.
- A sound screening of the athlete can now take place to ensure accuracy in exercise selection.
- During training competitive situations in the form of practice matches or competitive games and drills should be included.
- A key reason why many athletes hit a plateau during later stages of their development has to do with too much competition and not enough training during this stage.
- Competition is most valuable when it is used to develop strategic and tactical understanding. The focus must be on the learning process and not the outcome.

**Train to Compete Stage**

During the train to compete stage (females 15-21, males 16-23), athletes will focus on one sport in which they will train to excel. Athletes will train to re-enforce their sport-specific and position-specific skills as well as all of their physical qualities. During the train to compete stage of LTAD, this is where the competition often becomes serious. Athletes enter this stage if they have chosen to specialize in one sport and excel at the highest level of competition possible and therefore need to commit to high-volume and high-intensity training throughout the year. Nutrition, sport psychology, recovery and regeneration, injury prevention, and injury management also become an important component of the athlete’s programme. Competition becomes more prominent in the annual training plan. Train to compete athletes are generally not the average community sport programme participant; they are committed athletes with recognised talent who have chosen an elite pathway which requires huge amounts of dedication and training. The training to compete stage should aim to maximise all of the physical, mental, cognitive, and emotional capacities of the athlete. It also teaches the athlete how to handle the distractions of elite sport, such as travel, weather, different competition venues, media, spectators, and difficult opponents. Winning becomes a major focus during train to compete. However, coaches should help their athletes to select specific competitions that support strategic athlete development. The learning and development that occurs during these competitive events will prepare athletes for the next stage in their sporting progress, train to win. From a training perspective the athletes’ training potential is huge during this period, therefore an appropriate periodised annual training programme should be implemented in order to develop the appropriate fitness qualities throughout the year in order to optimise athletic development. Table 40 identifies the main physiological adaptations the athlete will go through during this stage and how to optimise their training around these adaptations.
Table 40

<table>
<thead>
<tr>
<th>Growth &amp; Maturation</th>
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</tr>
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<tbody>
<tr>
<td>The circulatory and respiratory systems reach maturity. These systems are generally able to deliver maximum output.</td>
<td>Aerobic and anaerobic systems can be trained for maximum output. Full sports specific energy system training can be implemented.</td>
</tr>
<tr>
<td>Muscles have grown to their mature size but muscular strength continues to increase reaching its peak in the late twenties.</td>
<td>Strength training can be maximised to improve overall strength development. Neuromuscular training should be optimised during this stage.</td>
</tr>
<tr>
<td>Skeletal maturation continues in males and females. Connective tissues are still strengthening.</td>
<td>Progressive overload in training should be continued.</td>
</tr>
<tr>
<td>By age 17 girls have generally reached adult proportions whereas boys may reach these proportions several years later.</td>
<td>Aerobic training for girls should be optimised. Coaches must be aware of how to deal with weight gain and the personal and social effects. Athletes must learn how to compete under differing circumstances</td>
</tr>
</tbody>
</table>

**Key considerations during the train to compete stage include:**

- Provide year-round, high intensity, individual event and position-specific training.
- Have the athletes perform their skills under a variety of competitive conditions during training.
- Place special emphasis on optimum preparation by modelling high-level competition in training.
- Continue to tailor and refine individual training programmes, recovery strategies, psychological preparation, and technical development.
- Emphasise individual preparation that addresses each athlete's individual strengths and weaknesses.
- Athletes must strive to deliver consistent high performance results in both training and competition.
- Coaches should consistently use Periodisation plans as the optimal framework of preparation according on the Periodisation recommendations of their sport’s LTAD plan.
- Coaches and athletes must plan for tapering and peaking for competition, to accommodate the large increase in training volume.
- Tapering means reducing both intensity and volume in training as athletes approach the date of major competition events. Tapering allows athletes to peak for major competitions, ensuring that they will perform at their best.
Train to Win Stage

This is the final stage of athletic preparation. All of the athlete's physical, technical, tactical and mental capacities are now fully established and the focus of the training should be shifted to the optimisation of performance whereby the athlete(s) is trained to peak for major competitions. Training is characterised by high intensity and relatively high volume. Frequent unloads should be planned into the training programme to help to prevent physical and mental burnouts. Training and competition-specific training/competition ratios are 25:75. By the time the athlete reaches this stage of their development they will be considered an intermediate to advanced athlete and therefore their training programme should replicate this and therefore a more advanced Periodisation model may be required to continue their physical development. Table 41 illustrates both the physiological and training considerations during the train to win stage.

Table 41

<table>
<thead>
<tr>
<th>Growth &amp; Maturation</th>
<th>Training</th>
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</thead>
<tbody>
<tr>
<td>Both males and females skeletal system should be fully developed.</td>
<td>Athlete can handle greater increases in training volume especially in weight bearing activities.</td>
</tr>
<tr>
<td>Both aerobic and anaerobic energy systems fully developed.</td>
<td>Supplementary anaerobic conditioning can be integrated (Speed End. &amp; RSA).</td>
</tr>
<tr>
<td>Skeletal muscle mass should be at its peak due to increase hormone production especially testosterone in males.</td>
<td>Athlete can manage greater volume and loads in regards to resistance / strength training.</td>
</tr>
<tr>
<td>Should be physically and emotionally mature to handle the pressure of competition.</td>
<td>Training should be sports specific and replicate both the physical and emotional demands of the sport.</td>
</tr>
</tbody>
</table>

Key considerations during the train to win stage include:

- Towards competition specific training must be tempered with a commitment towards long term development.
- During this stage training approaches consistently high intensity and specificity all year round.
- Strength is developed through the more advanced external loading strategies (undulating) and more complex exercises.
- Training the lactic energy system should be maintained.
- More emphasis on sports specific and individual specific work.
- Simulation of all competition conditions including competition specific training can slowly be introduced over several years and tapering techniques become more advanced.
Youth Periodisation

When it comes to designing the long-term Periodisation model for youth athletes the following model (Fig 26) can be used to provide a framework for the coach to work within. This model splits the programme into four separate phases; initiation (6-10 years old), Athletic formation (11-14 years old), specialisation (15-20 years old) and High performance (20+ years old). The training programme begins a lot more general in nature with a lower training volume (2-6 hours per week) as the athlete works through the phases training becomes more specific to the demands of the sport and training volume gradually increases across the phases as the athletes tolerance to training load increases. This model should only be used as a guideline as it doesn’t allow for individual differences such as gender, biological age, sport etc... and the training intensity and emphasis should be specific to the stage of development that the athlete is in.

*Fig 30. Periodisation of the youth athlete*

Fig 30. Above illustrates the different training emphasis, frequency and volumes of during different stages of the LTAD model from a professional football academy. This model is broken into the foundation (phase 1), early youth development (phase 2) and late youth development. During phase 1 the main training emphasis is on speed and suppleness whereas in phase 2 the main training emphasis is on speed and stamina (endurance) and in phase 3 the main training emphasis is on strength development. There is also an increase in the number of strength and conditioning training sessions per week that the athletes are exposed to throughout the programme as they develop.
Training emphasis and progressions should be based upon both the physical development and the competency of the individual athlete. Although the traditional LTAD model categorises training structure and outcomes into age specific groups, consideration should also be given to individual differences within a group. For example athletes that are early developers and competent movers should be progressed to further challenge them in order to maximise their development. In contrast late developers or young athletes with poor movement competency should be halted or regressed in order to ensure that they are not progressing to more complex tasks before they are ready to do so. Athletes need to earn the right to progress by demonstrating that they are competent during each training phase.
As illustrated all athletes should begin by developing basic movement skills with specific emphasis on co-ordination and balance whilst also starting to develop suppleness and flexibility. Once athletes possess good movement literacy and mobility the training emphasis should then focus on strength and energy system development.

**Chronological vs. Biological Age**

It is apparent that physical transformation happens at different rates in different children. Any coach who works with young athletes knows the large and sometimes unbelievable differences between two youth athletes of the same age. The chronological age refers to the child’s actual age based upon their date of birth whereas the biological age refers to their physical maturation age. Ideally young athletes should progressed through the LTAD programme based upon their biological age as opposed to their chronological age. A child’s biological age can be determined through measuring peak height velocity (PHV). PHV is the time in a child’s life in which they attain the most rapid height growth and tends to coincide with sexual maturation and rapid changes in bone structure. In girls, this typically happens at around twelve years of age, and in boys at age fourteen, although it can occur more than a year before or after these estimates. PHV is calculated by regularly taking height (sitting & standing) and weight measurements and then using a regression equation (http://www.pponline.co.uk/phv-calculator) to predict when an athlete will reach PHV. This information can be important to identify when young athletes will reach their window of opportunity for different training components.

It is apparent from this predicted model that females normally reach PHV before males. Before, during, and after PHV there appears to be certain periods in time in which young athletes are more sensitive to particular types of training (e.g. strength, speed, and hypertrophy). These time periods are often referred to as "windows of opportunity", which also implies that these opportunities can be missed if the appropriate training stimulus is not applied and therefore athletes may miss a vital opportunity to
maximise their athletic potential. It is also believed that there is a ceiling for athletic potential, and if these windows are missed, then that ceiling may be lower than if they were to train throughout that time. In contrast it is believed that athletes who exploit these “windows of opportunity” have a higher ceiling for their athletic potential than those who do not. This has led to the development of the term “periods of accelerated adaptation”, which are simply time periods of opportunity for athletes’ to make greater improvements in athleticism than otherwise possible. These periods of accelerated adaptation have many implications for training programme design, including: training content, intensity, volume, frequency, Periodisation, coaching style, and training group segregation. Therefore, it is believed that by calculating a child's onset of PHV it can enable the coaches to tailor the training programme in relation to the athlete's biological age as opposed to their chronological age in order to develop a better suited and more effective training programme. It is suggested that preadolescents benefit more from training methods which require higher levels of neural activation (sprint training and Plyometrics), whereas adolescents responded better to training types which target both neural and structural development (strength training and Plyometrics). It is also well known that adolescents respond more favourably to hypertrophy training than preadolescents due to the higher concentrations of certain hormones such as testosterone and growth hormone. Also, during the onset of the adolescent growth spurt, boys typically experience greater maturational improvements in all aspect of fitness than girls (e.g. strength and power), except for flexibility.

**Key messages:**

- Children and adolescents are not little adults and therefore should not be trained like them.
- Closely monitor for rapid changes in growth and maturation (PHV).
- Avoid early specialisation.
- Develop good general and all round movement competencies.
- Respect and adhere to training the correct components of fitness during the specific phases of growth and development.
- Ensure that training is fun and enjoyable with specific aims and objectives.
- Have a well-planned and designed approach for each development stage.

**Further reading**

- [http://www.pgedf.ufpr.br/Referencias08/Peak%20high%20velocity2006%20RO.pdf](http://www.pgedf.ufpr.br/Referencias08/Peak%20high%20velocity2006%20RO.pdf)