

Module 5 Endurance Training

Topic 1 Introduction to Endurance Training

Introduction to Endurance Training

Endurance is the ability to withstand prolonged exercise. The aim of any endurance training program is to improve the body's ability to sustain a particular level of physical activity. The exact nature of the training plan depends on the duration and intensity of the activity. In all cases of endurance training, both anaerobic and aerobic energy training is required; their importance being dependent upon the speed and duration of that activity the athlete is training.

When training for sprint events (10-60 sec), the aim is to increase the rates of high energy phosphate and glycolytic energy release by expending as much energy as possible in the shortest time in the most efficient manner.

While the predominant energy source for the actual activity is anaerobic, there is a huge requirement to enhance the aerobic system as well. The aerobic capacity increases the volume of training that can be completed, it speeds recovery from anaerobically induced fatigue, and it delays the onset of general training fatigue.

When training for middle distance (60sec to 10 minutes) and longer (5 min – 5 hours +) not only does the aerobic system need to be trained but also the anaerobic system as speed is important as it is a determining factor in how fast you can travel the distance. It also increases stroke volume, blood volume, slow and fast twitch muscle development and efficient recruitment of muscle fibres.



Effects of Endurance Training

Aerobic endurance training improves the mechanical ability to move air in and out of the lungs, increases the blood flow through the lungs and enhances the rate at which oxygen diffuses across the lung membrane into the blood. This allows an athlete to undertake increased training intensities without lowering the oxygen content of the arterial blood.

There are also changes in the nature of the arterial blood. Both the total red blood cell count and blood plasma volume increase in roughly the same proportions. This results in no overall change in concentration of haemoglobin but provides a greater overall transporting capacity of oxygen to the peripheral musculo-skeletal system.

Aerobic endurance increases the capacity of the heart to pump blood which results primarily from a larger stroke volume rather than an increased heart rate. Increased cardiac output can be attributed to either an enlarged ventricular cavities and/or an improved ability to empty blood from them. The changes in ventricular structure and function are responsible for the lower heart rate seen at rest and during sub-maximal exercise following a period of endurance training.

All forms of endurance training promote changes in the musculature. Several changes occur in muscle fibres which aid the extraction of increased amounts of oxygen from the blood and in more intensive work, facilitate the production of anaerobic energy.

Aerobic changes include increases in:

- The density of capillaries
- Myoglobin for running, transporting oxygen from the cell membrane to the mitochondria
- The oxidative enzymes in the mitochondria involved in carbohydrate and fat metabolism
- Mitochondrial number and size
- Size of muscle glycogen and fat stores



General Principles of Endurance Training

- Training is a method of stressing the body so that the body adapts to that stress and is then capable of functioning at a higher level
- The benefit of adaptation is dependent on selecting a method of training that will produce the desired adaptation
- Increases in the level of stress that are too large or occur too rapidly can result in a poor adaptation and a decrease in the capacity to exercise (overtraining)

Components of Training

Frequency	The rate at which the stress is applied, this is most commonly viewed as the number of sessions per week
Intensity	The quality or percent of the athletes maximal capacity at which the training is undertaken
Duration	The duration (time) of the exercise period

Progression

The rate at which a coach can make progress with an athlete's endurance capability will depend on a number of factors:

Physical maturity	When is it appropriate to begin endurance training with adolescents and what is the appropriate amount of training? Decisions should be made in relation to the risk factors at a young age of incurring articular cartilage injuries, musculo-tendinous injuries, growth plate injuries, overuse injuries and psychological burnout.
Stage of development	Is this the first time the athlete has commenced endurance training or is it their sixth year?
Response to training	A review of key indices such as waking heart rate and weight loss, tiredness and training times will give an indication of whether the athlete is adapting to training.
Desire to develop	What are the athlete's goals and are they motivated to improve? As a rule of thumb, usually 5-10% increase in distance covered per week is recommended in training volume.

Overload

- Increasing the number of training sessions or repetitions of an activity within a training session for example: adding an extra training session per week or progressing from running repeats of 4 x 400m to 5 x 400m
- Increase the duration of an activity for example: progress from swimming 3km a session to 3.3km per session
- Increase the intensity of an activity for example: lowering the time to complete the same activity or increase the heart rate when doing the activity such as cycling up a hill faster at an increased heart rate

If workloads remain constant, then the coach will only maintain an athlete's fitness level rather than improve it.

Specificity

Best results will always be achieved if you complete the majority of your training practicing the event that you will be participating in. Be specific to the energy and speed requirements of that sport.

Training at race speed or faster still needs to occur for some sessions. The body needs this type of stimulation for muscle recruitment and endurance, as well as the bodies energy system needs to adapt to that level of intensity.

So while specificity is important do not diminish the value of cross training. There's a lot to be said for cross training. Many athletes have found excellent benefits by supplementing their training with other sports that benefit their cardiovascular system while resting their skeletal system, for instance runners who do additional sessions in swimming or cycling.

Variation

Training sessions should be interesting and varied. This helps the athlete to physically and psychologically endure it and enjoy it! Creating variety can be as simple as:

- Changing the venues
- Changing the schedule and type of activities
- A change of emphasis from competitive to non-competitive



Individual Differences

Every athlete trains and performs differently to the next. Be sure to take the following points into consideration when designing a program:

Biological and chronological age	Has the athlete fully matured yet or is the athlete still developing?
Experience and training age	How many years has the athlete been training in endurance sport?
Tolerance to training	Are they handling the workload or is it too hard/easy?
Responsiveness to training	Is there an improvement?
Recovery	Some athletes require more recovery than others

Environmental tolerance	Some athletes will train better or worse in hot, humid or cold conditions
Lifestyle variations	Family or social commitments; morning or evening training
Reversibility	Forced layoff through injury or work/family commitments can influence progress and should be taken into consideration

Training Intensities

To fully maximise training sessions, a series of training intensities or training zones can be used. This can be taken from the **Individuals Anaerobic Threshold (IAT)** or percentage of maximum heart rate.

The IAT is defined as, the exercise intensity (e.g. speed, velocity, heart rate, etc) at which the rate of lactic acid production by the active muscles, begins to exceed the rate of lactic acid clearance from the blood. The result is, lactic acid begins to accumulate eventually forcing the exercise to slow down in order to dissipate the accruing hydrogen ions.

As the athlete gets fitter, his IAT should climb progressively higher and therefore, training sessions should be increased in intensity.

How to find your IAT go to www.lactate.com/lactate_threshold.html

Levels	Training Type	IAT	HR % of Max
L1	Recovery	Below 75%	50-60%
L2	Aerobic	76% - 85%	60-70%
L3	Intensive Aerobic	86% - 95%	70-80%
L4	Threshold	96% -102%	80-90%
L5	Lactate Tolerance	103% - max	90-100%
L6	Max Oxygen Uptake	max	90-100%

L1 Recovery Training	▪ This is done to help the body to recover from hard workouts. It is also done at a continuous, low intensity pace for a shorter period of time and distance and to avoid prolonged strain ▪ It takes the body more than 24 hours to recover completely from hard workouts even when we are fully fit ▪ Training hard every day without recovery time leads to injury and breakdown
L2 Aerobic Endurance Training	▪ Distance training is done solely to enhance endurance. It is done at a continuous pace of low intensity ▪ The intensity of this training would be at a point which your heart rate would be around 76 - 85% of your IAT. The duration for this type of training would be close to or exceed the length of the specific event for which you are training. The longer the event the more important this type of training becomes ▪ Training at this intensity for a duration of 45 minutes to 2 hours has been shown to be effective in altering the characteristics of muscle fibres so they resemble those of the type 1 fibre ▪ Changes that occur in response to low intensity endurance training include: - o Increased capillary density around muscle fibres - o Increased aerobic capacity - o Greater utilisation of fat as a fuel
L3 Intensive Aerobic	▪ This is a step up in intensity from aerobic to 86-95% of IAT. Perceived exertion is classified as somewhat hard to comfortably hard ▪ Duration of efforts should be 15-20 minutes with short rest recoveries for example: 5 x 5 minute efforts at 86-95% of IAT with 30 second recoveries

L4 Threshold Training	- Threshold training is completed at the anaerobic (lactate) threshold or IAT - This is usually done at 96-102% of IAT. Training at or just above the anaerobic threshold will increase an athletes VO2 max as well as shifting the anaerobic threshold pace to a higher percentage of VO2 max. In practical terms this means that an athlete will be able to race at a faster pace without the onset of muscle fatigue and soreness - AT training is usually done as time trials up to 60 minutes or at intervals of 10-15 minutes, with 3-5 minutes easy recovery between each repetition
L5 Lactate Tolerance	- This is done at a pace that exceeds the anaerobic threshold. Repetitions done at this pace will cause the lactic acid to rise above the anaerobic threshold after 1-2 minutes - Depending on the athlete's fitness levels, repetitions of this kind should not exceed 3 minutes and there should be 30 seconds to 2 minutes recovery between each repetition - As the repetitions do not exceed 3 minutes the pace is still very much controlled with the athlete working above 103% of IAT
L6 Maximal Oxygen Uptake	- Research has shown that this type of interval training reveals the greatest increase in Vo2 max. As the anaerobic threshold is exceeded repetitively it has a positive effect on the anaerobic threshold and the body will try to delay the onset of lactic acid accumulation by shifting the anaerobic threshold up closer to the level of VO2 max - Training consists of intervals of 2-5 minutes times 3-4 repetitions with equal time recovery. Efforts are completed at maximal intensity - It needs to be stressed that training at an intensity exceeding VO2 max has no obvious advantage and carries a much higher risk of injury even in short repetitions - This type of training should only be done by an athlete who is following a structured training program, has had at least 6 weeks of basic endurance conditioning and has prepared their body with some AT training

Weight Training for Endurance Sports

Generally speaking, endurance athletes do not need the bulk that some forms of heavy weights can induce.

Opinion is varied on the value of weight training for endurance sports. Is it worth the time and effort or should an athlete spend their time training in their specific event? It depends on the strengths and weaknesses of the particular athlete and the overall value of weight training to their specific program.

Strength activities that are very specific to the sport can be introduced for example: cycling up a hill in a large gear at a slow cadence; running up steep hills and swimming with paddles. Circuit training with light weights and body weight exercises can produce good results as well.



Go to the following websites in this Topic for more information about strength training

<http://sportsmedicine.about.com/cs/strengthening/a/aa123098a.htm>

<http://www.sport-fitness-advisor.com/strengthtraining.html>

Recovery

Recovery can be regarded as **the return to normal of physiological and psychological states** following training or competition.

- Improvements in fitness are only obtained if recovery from overload occurs. An athlete's adaptation occurs during the recovery period.
- Varying degrees of recovery are required at different times during the training/competition /program
- When peaking for competition, 100% recovery is required
- In heavy training phase recovery must be sufficient for the athlete to cope with the next training session

Recovery is dependent on the following factors:

- Maturity
- Training age
- Lifestyle
- Genetics

Recovery Methods

Work/rest ratio	▪ Giving more recovery time between intervals or repetitions ▪ Competition and training times -less competitions or a decrease in number of training sessions ▪ Increase the amount of sleep ▪ Time off from training
Nutrition	▪ Fluid and fluid replacement when training and not training ▪ Check weight every morning ▪ Rapid weight loss could indicate poor recovery
Physical therapy	▪ Stretching ▪ Hydrotherapies ▪ Self massage
Psycho-regulatory training	▪ Music ▪ Visualisation ▪ Progressive muscle relaxation ▪ Video ▪ Reading
Competition recovery activities	Immediately after competition: ▪ Drink /eat some fruit and or electrolyte replacement and water in first 10 minutes ▪ Walk/move in the first 10 minutes ▪ Stretch while warm ▪ Hot /cold shower /spa That evening/end of the day: ▪ Hot cold shower/spa ▪ Stretch and self massage (legs) ▪ Use relaxation skills Next day: ▪ Check weight and hydrate ▪ Eat well (carbohydrates and proteins) ▪ Swim and stretch in a pool

	▪ Light exercise - swim and bike Each week: ▪ At least 1 massage ▪ 2 pool stretch sessions ▪ Time out to relax
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Client Responsibility

It is important that the athlete takes on some responsibility for their own recovery time. They can do this by:

Work / rest ratios	▪ Monitor daily resting HR, body weight ▪ Stretch regularly
Nutrition	▪ Check fluid balance (urine colour) ▪ Eat a balanced diet ▪ Replace energy stores with good carbohydrates as soon as possible after training sessions
Physical recovery methods	▪ Hot/cold showers ▪ Massage and self massage
Psychological recovery	▪ Muscle relaxation techniques ▪ Breathing exercises ▪ Meditation ▪ Music



Go to the following websites in this Topic for more information about triathlon recovery training

www.trainingsmartonline.com/triathlon_training_and_recovery.php

For some athletes getting a good nights' sleep is not as easy at it seems. Here are some tips that may help:

- Practice relaxation techniques before going to bed
- Lie down to sleep only when you are sleepy
- If you don't fall asleep within 30 minutes after turning out the light get up and do some relaxation work
- Do the same thing if you wake up in the night and can't get back to sleep
- Get up at the same time every day

Things to avoid:

- Caffeine - coffee/ tea, coke, chocolate
- Nicotine
- Alcohol
- High protein meals



Go to the following websites in this Topic for more information about recovery and regeneration

[www.ask.net.au/downloads/Faster Higher Stronger Coaching UK.pdf](http://www.ask.net.au/downloads/Faster_Higher_Stronger_Coaching_UK.pdf)