H2 TRAINING FOR AEROBIC POWER

Key Notes

Interval training — Interval training results from short to moderate periods of exercise interspersed with recovery.

Long slow distance training — Long slow distance training (LSD) is performed at a relatively low intensity (i.e. 60–70% max HR) with the main objective being distance covered rather than speed.

High-intensity continuous training — This type of training is normally performed at exercise intensities approximately 80–95% max HR, with the emphasis on speed rather than distance covered.

Fartlek — Fartlek or speed play is a form of continuous training whereby the athlete changes pace during the session, i.e. slow then fast then slow than fast pacing.

Circuit training — Circuit training involves a series of selected activities performed in a given sequence. Normally associated with resistance training, circuit training has been adapted for the needs of improving aerobic power.

Related topics

Bioenergetics for movement (B)
Pulmonary adaptations to exercise (D)
Cardiovascular adaptations to exercise (E)

Interval training

With interval training, short to moderate periods of exercise are alternated with short to moderate periods of recovery. Research has demonstrated that athletes can undertake considerably more total work in a session if they alternate the short intense active bouts followed by recovery. The key components to interval training are the **work:rest ratio**. Depending on the energy system being trained, the work:rest ratio varies. For improvements in aerobic power and capacity, the work bout is normally from 1–3 minutes of high intensity followed by a recovery period of approximately 1–3 minutes. Interval training to enhance the aerobic system normally requires a work:rest ratio of 1:1 or 1:2. For example, an **interval set** for a swimmer could be six **repetitions** of 100 meters in around 75 s followed by a 75 s recovery between repetitions (and no longer than 120 s). After the set a longer recovery may ensue before a second set of repetitions, either of similar activity or a variation, takes place. *Table 1* provides an example of an interval training session for a swimmer. During the rest periods the athlete may either remain stationary or work at a significantly reduced pace (i.e. passive or active rest), although the heart rate should have decreased to about 60% max HR before the next repetition.

Interval training can be used for almost any sport and can be adapted by selecting the mode of training as well as the intensity of the work bout. In planning an interval session, the variables of length of the work bout, intensity of

Table 1. Example of an interval training session to improve aerobic capacity for a swimmer

Set	Repetitions	Distance (m)	Work time	Rest time
1	6	100	75 s	75 s
2	6	100	75 s	75 s
3	4	200	200 s	180 s
4	4	400	360 s	300 s

the work, duration of the rest bout, number of sets, and number of repetitions in a set need to be addressed.

Long slow distance training (LSD)

The use of LSD runs, cycles or swims involves performing exercise at a low intensity (60–70% max HR) for durations longer than the competition event. One of the beliefs for this type of training is that improvements in endurance are proportional to the volume of training. This is particularly prevalent amongst some coaches of elite swimmers with the adage that more distance in a session results in better performance. Recent evidence suggests that short, intense bouts of exercise are superior to prolonged low levels of training. Indeed, a training study reported in 1991 on swimmers demonstrated that more intense training for 90 minutes a day resulted in similar or better performances than swimmers who trained for 180 minutes a day.

However for older populations and those who exercise purely for health benefits, use of LSD may be preferable to undertaking more intense bouts of training. Under these circumstances, LSD is effective because it can be performed at a comfortable pace and, as long as the distance is not too great, a less risky way to train.

High-intensity continuous training

This type of training is performed at work intensities at approximately 80–95% max HR, and is very effective for training endurance athletes without working out maximally. Training at a constant pace which is near (but not at) race pace enhances the athlete's ability to judge pace, yet provides a very good aerobic stimulus. Serious athletes do need to train near their competition pace in order to develop limb speed, strength and local as well as cardiovascular endurance. The downside to this type of training is that it is intense and should not form the sole training strategy since overuse injuries may occur. Nevertheless it should form an important part of a performer's training since one of the key principles of training is specificity.

Fig. 1 illustrates the effect of training intensity on aerobic capacity. The figure clearly demonstrates that exercise intensities above the lactate threshold (which normally occurs between 65–80% $\dot{V}O_{2max}$) provide the best stimulus. It is likely that these training intensities may correspond to V_{OBLA}, which has been shown to significantly improve aerobic performance.

Fartlek

The Swedes have used fartlek training since the 1930s for improving aerobic capacity in distance athletes. Fartlek combines the aerobic requirements of continuous exercise with the anaerobic requirements of interspersed speed intervals, and is often undertaken in the countryside. The concept of fartlek is to run or cycle at a steady pace for a set distance and then to sprint or exercise intensely for a short distance before going back to the steady pace. This can be

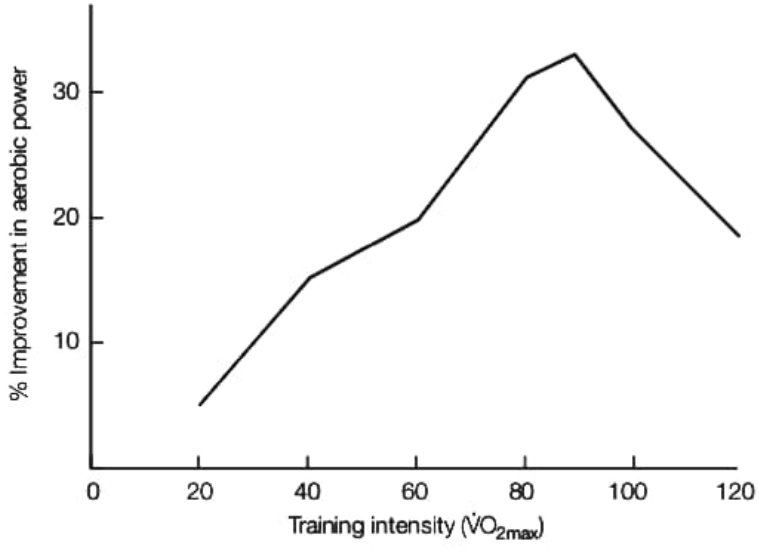

Fig. 1. Relationship between training intensity and improvements in aerobic capacity.

achieved for example, by running steady between two or three lamp-post distances and then running briskly between one set of lamp-posts, and so on. Fartlek training provides variety and fun, yet is a good way to enhance aerobic power and capacity.

Circuit training

In circuit training a series of different activities is performed in a given sequence. A circuit normally has at least six stations wherein the individual will exercise for a given period before resting (or not) and moving on. Alternatively, each station requires the individual to complete a set amount of work before moving on. Improvements can be seen when the time taken to complete each station or the whole circuit is reduced. Although mainly used to develop strength, circuit training can be adapted for improvements in both local muscle endurance and overall cardiovascular endurance.

H3 TRAINING FOR ANAEROBIC POWER

Key Notes

Training the ATP-PC system	Training to improve the ATP-PC system involves short, very intense bouts of activity followed by recovery. Interval training is employed.
Training to improve the glycolytic system	Training the glycolytic energy system also involves interval training, although at a marginally lower exercise intensity than above and for a longer duration for each repetition.
Related topics	Bioenergetics for movement (B)

Training the ATP-PC system

The ATP-PC system is the major energy source for intense bouts of activity that last for 2–10 seconds. This type of activity is important not only for weight-lifters and field event throwers and jumpers in athletics, but also as part of many team sports such as soccer, rugby, netball, hockey, basketball, and volleyball. A specific form of interval training is employed to improve the ATP-PC system which involves very intense bouts of high-intensity activity lasting no longer than 10 seconds with recovery periods varying between 30 and 300 seconds. Since PCr is totally replenished in around 300 seconds and 70% recovered within 30 s, the rest period can be altered either to compromise replenishment or to ensure that complete recovery is achieved. When devising the number of repetitions in a set, the fitness level of the athlete needs to be gauged.

Training to improve the glycolytic system

Glycolysis provides the significant contribution to energy when intense bouts of exercise progress beyond 10 s and are less than 60 s. Interval training in which the work bout lasts between 20 and 60 s is ideal to improve energy from this system. The rest period needs to vary dependent on whether the need is to tolerate and promote clearance of lactic acid or whether the need is to enhance the activity of glycolytic enzymes. The former can be achieved by ensuring that the rest period is between 60 and 240 s so that lactic acid levels in muscle and blood will still be elevated prior to the next repetition. The latter can be achieved when the rest period is around 20 minutes, thus allowing for clearance of muscle lactic acid in an active recovery process.