

Endurance Training

Endurance, the ability to sustain physical activity for long periods, is important for sports with a duration of longer than a minute. Endurance is not only an ability of long-distance runners. A good endurance background is necessary for most athletes, from basketball or soccer to triathlon. The main benefit of endurance for most sports is to withstand the strain of training and competition. Furthermore, an athlete with a good endurance base will cope with the fatigue of training, school work, and industrious lifestyle more easily than without this foundation.

In sports, fatigue is public enemy number one! Those athletes who cannot effectively cope with fatigue have a high probability of performing poorly and losing the game, race, or match. Fatigue also affects the ability to stay focused, resulting in technical and tactical mistakes and throwing or shooting inaccuracies. This explains why, toward the end of a game or match, more mistakes are visible. If you want to improve your game, you must develop your endurance capability.

Endurance is of two types: aerobic, in which the athlete always performs the activity in the presence of oxygen, and anaerobic, in which the activity is fast, dynamic, and of short duration, so the heart does not have time to pump oxygen to the working muscles to produce energy.

Anaerobic endurance is more specific to team sports, tennis, martial arts, and so on, and longer duration sports, such as cycling, swimming, triathlon, distance running, cross-country skiing, depend more on the aerobic capacity. However, most athletes need a good aerobic base before they stress the more sport-specific anaerobic endurance.

Endurance training also has a visible health benefit. Individuals involved in endurance activities have stronger hearts and lower heart rates and blood pressure. Few of these individuals experience cardiorespiratory diseases, and the incidents of death from cardiac disease are rare. Athletes performing endurance activities use more fat as a fuel; therefore, they look trimmer. Make endurance activities part of your lifestyle.

Like speed, endurance performance is strongly influenced by genetics, because the proportion of slow-twitch muscle fibers, versus fast-twitch, largely determines an athlete's endurance potential. Genetics, or the biological makeup of an individual, may affect up to 70 percent of final performance in a sport or event in which endurance is the dominant motor quality (Matsui 1983). Other factors influencing endurance performance are psychological, such as motivation, willpower, and competitiveness. However, just because an athlete is naturally gifted for endurance activities does not mean that he or she will always be the best performer. Training ethics, determination, and motivation for hard work often can overcome a lack of talent. The best example that comes to my mind is the Czech runner Emil Zatopek, who in the 1950s and 1960s won Olympic gold medals in both the 5,000- and 10,000-meter run, breaking several world records. Emil was not the most gifted athlete, but his hard work and determination made him one of the best remembered individuals in athletics. Irrespective of talent, from childhood to maturation, all athletes can improve their endurance capacity: in early childhood as much as 10 to 20 percent per year. As they reach athletic maturation, improvement may decrease to 5 to 10 percent, although Olympic-class athletes are expected to improve their endurance potential anywhere between 3 and 7 percent annually.

Performance ability in endurance-dominant sports improves constantly during childhood, from early prepuberty to postpuberty and late adolescence. Athletes reach high performance during maturation. Female athletes may peak at a slightly earlier age than their male counterparts, perhaps due to the tendency of girls to mature earlier than boys. Throughout these development phases, boys perform better overall than girls (Hughson, 1986).

Except swimming, most endurance-dominated sports such as running, cycling, triathlon, rowing, cross-country, and canoeing are not as popular among children as team sports. Yet, the medical community and fitness specialists often associate these activities with the health benefits of physical activity, therefore implying that more people should be engaged in endurance activities. Unlike team sports, children can perform endurance activities individually or in small groups, and at an individual pace so they can enjoy them. Involvement in such activities can mean the beginning of a lifetime of fitness enjoyment and health benefit. It is not mandatory to train three or four hours per day to enjoy these sports. Shorter duration of exertion can also improve endurance, especially in early childhood.

The adaptation of children's organs and systems to endurance training has many benefits. These include improving the pulmonary (lung) and cardiac (heart) functions, and increasing the number of red blood cells that transport oxygen to the working muscles. It is only in the presence of oxygen that glycogen and fatty acids burn to produce the energy necessary for endurance activities. As the athletes train, they also become more economical in using energy, which results in improved performance.

Endurance Training Model for Initiation

Prepubescence represents the beginning of long-lasting athletic activity for many. Children's skills are poor in the early years because they have low economy of locomotion and poor tolerance for heat stress.

Prepubescent children have an inferior cardiac output (the amount of blood the heart pumps in one minute), low blood oxygen carrying capacity, and a low $\dot{V}O_2\text{max}$. However, athletes score consistently better than nonathletes, which demonstrates a certain adaptation to training. I should also mention that the average prepubescent boy has greater endurance than the average girl, partly because toward the end of prepuberty, girls have about 10 to 15 percent lower $\dot{V}O_2\text{max}$. We can explain this difference mostly because $\dot{V}O_2\text{max}$ relates closely to lean body mass, increased muscular system, and low body fat, which are greater in boys. On the average, boys perform 10 to 20 percent better than girls in endurance activities. Before puberty, however, $\dot{V}O_2\text{max}$ improves for both boys and girls, as does their endurance performance, both of which are due to training and the size increase of their lungs, heart, and muscular system (Hughson, 1986; Roberts et al., 1987).

Lung functioning represents a strong element in the oxygen delivery system; however, because of improper breathing techniques, as lung work increases, breathing economy and the amount of air being ventilated does not increase correspondingly. In fact, children hyperventilate, meaning a high and superficial breathing, compared with adult athletes, whose breaths are longer and deeper. Respiratory frequency decreases with age. The respiratory frequency at rest for prepubescent children is around 18 to 20 breaths per minute, and by the time they reach postpubescence, it decreases by approximately three or four breaths per minute. Children's cardiovascular systems (heart, arteries, and veins) are different from adults. The heart rate, number of heart beats per minute, during both rest and activity is higher at prepubescence (about 200 to 215 beats per minute) and falls progressively during the other developmental stages. As children grow, the heart rate frequency decreases while the efficiency increases; the lungs' vital capacity increases, which is the amount of air brought into the lungs that the body can use (Hebbelinck, 1989; Shephard, 1982).

As a result of exercise, red blood cells and hemoglobin (a complex molecule in red blood cells that contains iron and enriches the capability of red blood cells to transport oxygen) increase. At the same time, this elevates the oxygen delivery and, consequently, increases the efficiency of aerobic endurance. During prepubescence, hemoglobin concentration is approximately equal for boys and girls, but the differences in endurance proficiency rely on the other factors mentioned previously.

Scope of Endurance Training

Although you must apply it carefully, the main scope of training for prepubescence is to make children progressively able to perform an increased duration of physical activity before experiencing fatigue.

You can enhance anaerobic or aerobic endurance training through different forms of activity, such as play; games; or other endurance-related sports, for example, track and field, swimming, cycling, or cross-country skiing. Similarly,

you can organize drills from team sports so that a prolonged duration or several repetitions can have positive results in endurance development.

You don't have to develop endurance for prepubescence in a regimented fashion by running laps for a given distance or speed. This would in fact be a gross disservice to children. The earlier children feel pain, the faster they will be hurt, burned out, and even willing to quit sports.

Endurance activity should be part of the multilateral development at this stage of development, and often children can perform it as part of or in addition to technical training. You should organize forms of endurance-related activities that are enjoyable, fun, and interesting for children, so they can get cardiorespiratory development as well as varied and pleasant training.

Program Design

Prepubescent children seem to cope better with activities that are either short and fast or longer than two minutes and at a slow pace. Competition distances between 200 and 800 meters or yards are unsuitable for prepubescent and pubescent children. These distances should not be part of any track and field program for young athletes, because they are unable to tolerate the lactic acid buildup specific to this type of high-intensity activity. It is only in late adolescence that athletes should incorporate these distances into a competitive program. At this stage of development, children have had the time to build strong aerobic and anaerobic backgrounds, improve the power and efficiency of the cardiorespiratory systems, and, as a result, improve their lactic acid tolerance capability.

View prepubescence as the time for early anatomical adaptation of the heart, lungs, joints, and muscles to prolonged physical activity. This should be the base on which athletes build demanding aerobic and anaerobic endurance for specialization and high performance.

Training programs that boys and girls perform together (coed) ought to be carefully planned and progressively increased over at least two or three years, depending on the entry age in the sport. Organizing such programs requires carefully applying the principles of individualization, with the knowledge that children each have their own level of tolerance to work and fatigue, and a different degree of motivation.

Now is the time to introduce different forms of play and games, and to involve children in team sports with simplified rules and the least rigidity possible. In addition, to facilitate restrictions and scheduling, children should play for as long as it is fun and not stressful.

In addition to play and games, children can develop basic endurance by running on varied terrain using the least boring methods. The instructor should use his or her imagination to organize running in small groups with various tasks and games of tag. The emphasis should be not only on running, but also on performing various tasks during the course.

Children can develop basic endurance through individual activities such as swimming, boating, cycling, or cross-country skiing. However, do not make such activities into competitions, but do them because the children enjoy it.

You can use table 7.1 as a guideline to plan endurance activities for prepubescent athletes. The first form of training considers play and games, which children could perform at a fast pace for a short duration, and slower if the activity is prolonged. The number of repetitions, meaning how many games or how many

Table 7.1 **Periodization Model for Endurance Training for Prepuberty**

Forms of training	Distance duration	Speed of activity	Number of reps	Rest interval (min)
Play and games	—	Medium to fast (for short play)	2 - 4	Variable
Continuous relays	40 - 200 m/yd	Medium	2 - 4	2 - 3
Unstressful aerobic activity, such as running, swimming, rowing, and cross-country skiing	20 - 60 min	Low and steady	1 - 2 (depending on the distance)	—

times children do a game in a session is two to four, with a rest interval as long as necessary so children are fully rested before starting again.

If children perform relays of longer distance, up to 200 meters or yards, the speed cannot be higher than medium. At this age children cannot run 200 meters or yards with high velocity. Children can repeat relays two to four times, always taking a break of two or three minutes before doing it again.

Children can easily perform longer duration activities, such as running, swimming, and cross-country skiing, over 20 to 60 minutes if the speed of activity is low. While performing such activities, do not push the children. Let them find their own activity speed and allow the real challenge to be the distance. It is better to have them perform an activity for a long distance at slow pace than to do a short distance and a fast pace.

Endurance Training Model for Athletic Formation

As athletes reach puberty, their endurance improves. If pubescence represents the beginning of organized training, then young athletes can expect fast improvements in endurance capacity simply because their pretraining endurance level was low.

Children can improve $\dot{V}O_2\text{max}$ during puberty, with the highest gains occurring during the growth spurts. Although $\dot{V}O_2\text{max}$ increased at approximately the same rate for boys and girls during prepubescence, puberty accelerates endurance gains for boys. This is mostly because of increased muscle mass in boys, whereas girls tend to gain body fat instead. As a result, boys have a higher aerobic capacity, and a larger cardiac and pulmonary capacity (Hughson, 1986; Shephard, 1982).

Most changes pubescent athletes experience are genetically determined. Some of their dramatic changes during puberty manifest in their aerobic endurance. Young athletes experience visible phases of stagnation of endurance development. At times, coaches notice a temporary plateau, or even a decline, in aerobic endurance, in spite of the continuity of training.

You can also observe temporary changes in trainability during pubescence. About half a year before a leap in growth, there can be a visible decrease in endurance training potential. Before and after a growth spurt, however, gains in endurance capacity appear at a faster rate. We can conclude, therefore, that the level exerted in endurance capacity depends on the children's changes in dimensions.

Pubescence for girls represents the stage of fastest and probably the best gains in endurance, although as already mentioned, their male counterparts accelerate faster. It is possible that girls might never reproduce the performance they reach during pubescence, unless they are participating in organized training. The main reason for performance depreciation in girls is postpubescent gains in total body fat.

The size of the heart and lungs directly affects the oxygen delivery system (cardiorespiratory). Boys' organs are better developed due to the anatomical size of the lungs and increased involvement in physical activities. The respiratory frequency at rest is approximately 18 breaths per minute for both sexes; however, compared with adults, children's respiratory pattern is more superficial and rapid. This makes children hyperventilate during exercise, which results in higher breathing frequency and lower efficiency in oxygen use. Puberty represents the stage of other gender differences as well, such as red blood cell count and hemoglobin concentration, with boys having significantly greater values due to increased physical activity.

Although heart rates during exercise decline with age, beginning with puberty and continuing to maturation, boys have slightly lower rates because of a larger and more powerful heart. At puberty the highest rates begin to fall at approximately one or two beats per year. The highest heart rate during exercise is also recorded before or during puberty, ranging from 195 to 215 beats per minute (Bailey, Malina, and Mirwald, 1985; Malina, 1984). Factors such as poor fitness levels, obesity, anxiety, and heat stress also influence heart rate, especially for untrained individuals.

During the phases of growth spurts, children may be vulnerable to muscle injuries resulting from long-distance activities, and if exaggerated the overuse syndrome may be visible. This can be even more likely when running long distances on hard surfaces. Therefore, consider the benefits of regular aerobic training against the eventual negative results. Parents and coaches should be careful in applying regimented training that may result in pain or even health risks. Long-distance activities require an extended training time, which may stop children from doing enjoyable social activities such as play and learning other skills.

Scope of Endurance Training

Any endurance training program designed for pubescent athletes should be an attempt to increase the endurance foundation for aerobic and anaerobic endurance, and to take any endurance gains made during prepuberty to a higher level.

An equally important scope is to continue developing and strengthening the cardiorespiratory system, increasing the power of the heart to pump blood to the working muscles more effectively. This will be visible through a progressive decrease in heart rate and an increase in the cardiac output or the amount of blood pumped per minute.

From puberty on there is a clear differentiation of endurance capacity between girls and boys, so training programs have to address their specific conditions.

View pubescence as the beginning of an effectively organized endurance training. Its development benefits overall fitness and buffers fatigue. The better the endurance level, the easier an athlete will cope with an increased number of training hours per week and the total demand in training, which will increase during puberty and postpuberty. Improved endurance will also result in faster recovery between training sessions, making athletes better conditioned to tolerate a progressively increasing training load.

Program Design

Endurance training for pubescence should progress toward specialization, in which training specificity becomes dominant.

As table 7.2 shows, the program can expand to include middle-distance events in track and field, and increase to longer distances, from 800 meters to 2,000 meters (.5 mile to 1.25 miles). Because running is an important activity for most sports, now is the time to teach children a correct technique for running. To accomplish this, design the program around technical acquisition, meaning that the athlete should perform the distance or the number of repetitions only as long as the skill is correct. When fatigue sets in, technique starts to fall apart, and continuing work under these conditions will be counterproductive.

Continue to develop most of the endurance program during the technical and tactical work. However, you should also consider performing endurance training apart from this work (the so-called conditioning). In such situations, the instructor must remember that each segment of training is fatiguing and should consider total fatigue when calculating the training load (including conditioning).

Consider the following steps when progressively increasing the load in endurance-related training:

1. At first, increase the duration of a training session from 45 minutes to 60, 75, and up to 90 minutes.
2. Increase the number of training sessions per week from two or three to four, five, and in some sports higher.
3. Increase the number of drills or repetitions per training session. When the duration of a session reaches the limit, and you have maximized the num-

Table 7.2 Periodization Model for Endurance Training for Puberty

Forms of training	Distance	Speed of activity	Number of reps	Rest interval (min)
Play, and relays, as in prepuberty	40 - 200 m/yd	Fast to medium	3 - 5	Variable
Interval training runs	200 - 400 m/yd	Medium	3 - 5 (low numbers for 400 m/yd)	2 - 3
Aerobic activity (long repetition)	800 - 2,000 m (.5 mi to 1.25 mi)	Medium and steady, at times feel slight discomfort	1 - 3	3 - 5

ber of workouts per week, the next step is to progressively do more repetitions per training session. Now training demand is higher and endurance benefits increase.

4. Increase duration covered in each repetition. If a drill or repetition has lasted 45 seconds in the past, at this stage of load increment, you may extend the duration to 60, 70, or more seconds.

As the duration of training expands, children start perspiring more and therefore should take fluids before, during, and after training. Any parent or coach must consider frequent water breaks, especially in hot and humid conditions, so that children have a body heat balance and avoid losing too much fluid.

Training Program

A training program designed for pubescent athletes should still consider different forms of play and games, as well as elements of more formal training aimed at developing endurance. As much as possible, the coach should consider variety and enjoyment in the complexity of activities he or she is planning. Although training for endurance often means perseverance in repeating the same kind of work over and over again, avoid regimentation.

Repetition of certain types of endurance training should not necessarily mean boring laps. You can make training enjoyable by varying the distance, the terrain, and arranging a fun course. For team sports, coaches should organize the duration of technical and tactical drills with endurance development in mind. A 60-second duration drill will have not only technical or tactical merit, but also sport-specific endurance development.

An endurance training program should include different distances or durations, because they each may develop a component of endurance. For instance, an activity with a long, steady pace will develop the pumping power of the heart, the stroke volume (the amount of blood pumped per beat), and, in the long run, will decrease the resting heart rate. Some types of work, mainly aerobic training, develop the capillary network, the branching out of veins and arteries, so that oxygen will travel to every part of the body.

Interval training, which is a method of repeating a distance or time several times, with a prescribed intensity, duration, and rest interval, strengthens the heart and lungs. If the duration of work is between two and three minutes, the athlete develops $\dot{V}O_2$ max. By performing shorter repetitions, the athlete will progressively adjust to anaerobic endurance. Because such a training program produces lactic acid, a fatiguing by-product of anaerobic training, you must apply it carefully and progressively. Its maximum use will be during postpuberty, and mostly during training for high performance. From this point of view, pubescence, especially the latter part, is the time to introduce interval training.

The type of interval training appropriate for puberty is mostly anatomical adaptation, rather than training for physiological improvement and performance increases. This means medium distance and time, with medium intensity, and a rest interval for a full regeneration. As a result of such a program, children should have the time (two to four years) to adjust anatomically before training physiologically. Children can achieve the anatomical adaptation phase of interval training without the typical strain of short- and high-intensity interval training, which results in a high heart rate (close to or even over 200 beats per minute). Such a

heart rate has a low stroke volume and decreases the ability to effectively pump oxygen and the glucose needed for producing energy. There is a misconception that interval training is short and must hurt.

The main training law for endurance training for puberty is "Before training physiologically, train anatomically" (the anatomy of the cardiorespiratory system).

Considerations for Specialization

Endurance and endurance performance improve steadily throughout the growing years. During adolescence, you may notice a slight acceleration for males, but not as much for females. The mean $\dot{V}O_2$ max remains at about the same level (Armstrong and Davies, 1984; Shephard, 1982). As athletes better adapt to training, the energy expenditure becomes more effective, more economical, and performance may constantly improve. Improved performance, therefore, relates to improved energy economy, independent of the dynamics of aerobic power.

The biological differences, as well as performance differences, continue to grow during postpuberty. In addition, females are less likely to reach their full physical potential because of social factors and not necessarily because of biological handicaps. Society is used to the fact that sport participation is dominated by males. Although many changes have occurred in societal acceptance of equal opportunities for males and females in sport participation, men's sports still have higher visibility. The lack of prominent role models, reduced interest from the media, and even the peer conduct regarding women's participation in sports all represent social and psychological constraints for many young girls. Changes in attitude should not exclude the possibility of bridging the gap between endurance performance for female and male athletes.



Scope of Endurance Training

On the foundation of endurance built during prepubescence and pubescence, training now becomes more specific to meet the needs of the selected sport.

Diversity training that I promoted in the past is progressively narrowed during this development stage, especially as the athlete approaches high performance. For endurance training, diversity means variations and combinations between aerobic and anaerobic training.

The long-term approach to endurance training pursued during prepuberty and puberty will reach a peak during postpuberty and maturation. From postpuberty on, however, the coach has to develop annual plans that include aerobic and anaerobic training, as well as introducing ergogenesis training.

Ergogenesis is a term of Greek origin. *Ergon* means work, and *genesis* refers to beginning, creation. In sport interpretation, ergogenesis means create the work to combine the elements of endurance as the specifics of the sport requires. As such, ergogenesis refers to the total contribution of anaerobic and aerobic endurance to performance, expressed in percentage. For instance, the ergogenesis of rowing is 83 percent aerobic and 17 percent anaerobic. In 800-meter running it is 51 percent aerobic and 49 percent anaerobic. In 200-meter swimming it is 70 percent aerobic and 30 percent anaerobic. In basketball it is 40 percent aerobic and 60 percent anaerobic. Consequently, in the annual plans the coach develops, he or she has to introduce phases in which ergogenesis, or the right combination between aerobic and anaerobic endurance, dominates. The result of such a program is a progressive improvement of performance.

Program Design

Because postpuberty represents the stage of specialization, when athletes start to specialize in an event, sport, and position in team sports, training specificity gets high visibility. Even under these conditions, however, you should not exclude multilateral training. The athlete must continue to work on the foundation of aerobic capacity, the ability to produce energy under aerobic conditions.

Anatomical adaptation of the cardiorespiratory system, strengthening the heart and improving the oxygen transportation system, must be a constant objective of aerobic training. A training program for postpubescence should continually develop aerobic capacity to effectively produce and efficiently consume the oxygen this system provides.

During the first two or three years of postpubescence, developing the aerobic capacity becomes the major training objective for individual sports and team sport athletes. The last part of postpubescence endurance training becomes more specialized according to the needs of the selected sport. As mentioned previously, from now on, use anaerobic endurance and ergogenesis to build a strong aerobic base.

Constantly improving aerobic capacity to the highest possible level has certain benefits:

- It develops the oxygen transport system, in which a powerful heart plays an important role.
- Athletes can prevent hyperventilating by focusing on active exhalation—filling the lungs with fresh, oxygen-rich air—by taking deep, steady breaths.

- High aerobic capacity positively influences the anaerobic capacity because it lengthens the ability to function before reaching fatigue. An athlete with a high aerobic capacity can tolerate anaerobic work, with its highly fatiguing lactic acid buildup.

- An athlete with a high aerobic capacity can recover quickly from fatiguing training sessions or after repeating work or drills. Consequently, the athlete can slightly reduce the rest interval between repetitions and can perform more work. More work is usually translated into improved performance.

A training program designed for postpubescence also has to develop the anaerobic capacity, especially during the second part of this stage. This refers to the ability of an athlete to produce energy in the absence of oxygen and to progressively tolerate the lactic acid buildup, which is the by-product of anaerobic training.

Developing aerobic or anaerobic capacity depends on the selected training method. Long-distance training methods, including long-distance uniform (steady state), alternate interval training of long repetitions, and specific racing endurance, develop aerobic capacity. Particularly for team sports, however, the instructor should remember that athletes also can develop these capacities through specific drills, especially tactical drills. Designing longer duration drills, over three minutes, improves the aerobic component, whereas drills of 30 to 60 seconds improve the anaerobic capacity.

The training methods I suggest in table 7.3 do not exhaust what is available in sports training. However, it is critical for this stage of development, especially the early postpuberty years, to constantly emphasize aerobic training, both the uniform long-distance runs and long repetitions of interval training. Please remember that a solid aerobic base developed at this age, without strain and stress, guarantees improved performance during maturation. After all, athletes reach high performance at maturation and not at early postpuberty! Pushing young athletes often burns them out, resulting in the young athletes quitting sports.

Table 7.3 suggests the duration of rest intervals. This is just a guideline. If you want to calculate the rest interval between repetitions, please use the heart rate method, as follows:

1. Take the heart rate immediately after a repetition of an activity.
2. Continue to monitor the heart rate. When it drops to 120 beats per minute, the athlete should start another repetition.

Table 7.3 **Periodization Model for Endurance Training for Postpuberty**

Forms of training	Distance/ duration	Speed of activity	Number of reps	Rest interval (min)
Uniform training (long distance)	2,000 - 5,000 m/ 1.25 - 3.1 mi	Low to medium	1	—
Interval training: long repetitions	800 - 1,500 m/ 0.5 - 1 mi	Medium	2 - 4 (6)	2 - 3
Interval training: short repetitions	200 - 400 m/yd	Medium	4 - 6	3 - 5
Tactical drills (long) for team sports	2 - 5 min	Medium	3 - 6	2 - 3
Tactical drills (short) for team sports	30 - 60 sec	Fast	4 - 6 (8)	3 - 5

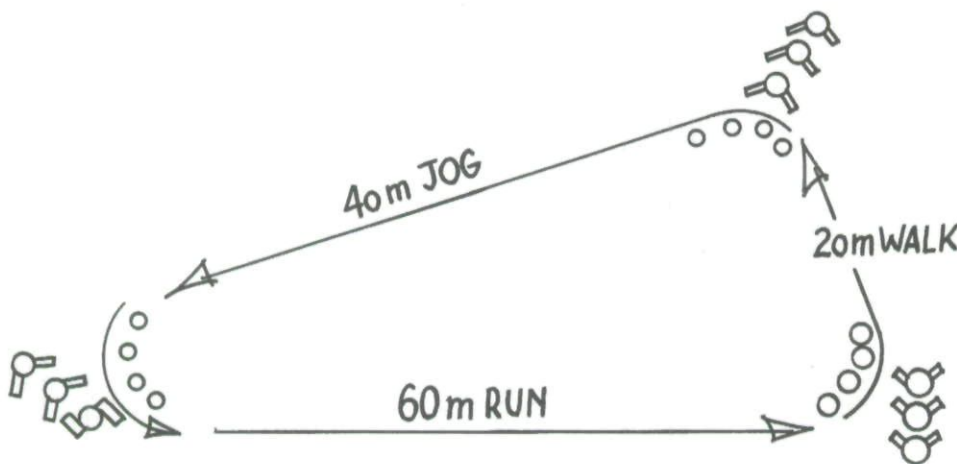
Exercises for Prepuberty

The following four exercises are appropriate for prepuberty athletes.

CONTROLLED SPEED POLYGON

Focus: general endurance

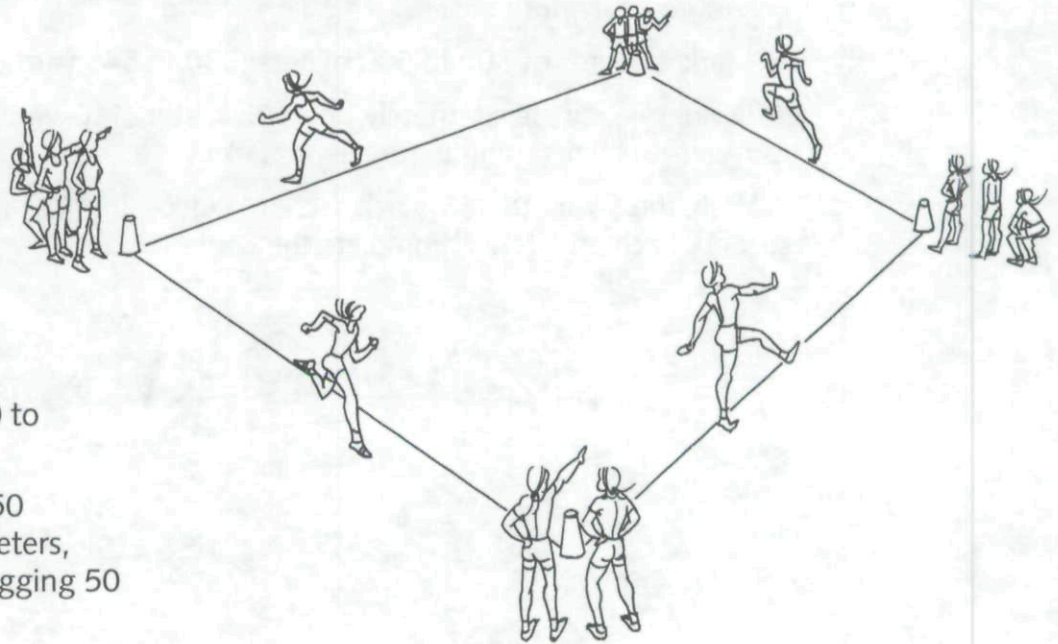
1. Create your own shape (or ask the athletes).
2. Maximum running time is 15 seconds in any one section.
3. The class is in small groups, one at each section start point.
4. Include a variety of speed movement (e.g., jog for 40 meters or yards, run for 60 meters or yards, walk to recover for 20 meters or yards, and repeat).



SQUARE

Focus: general endurance

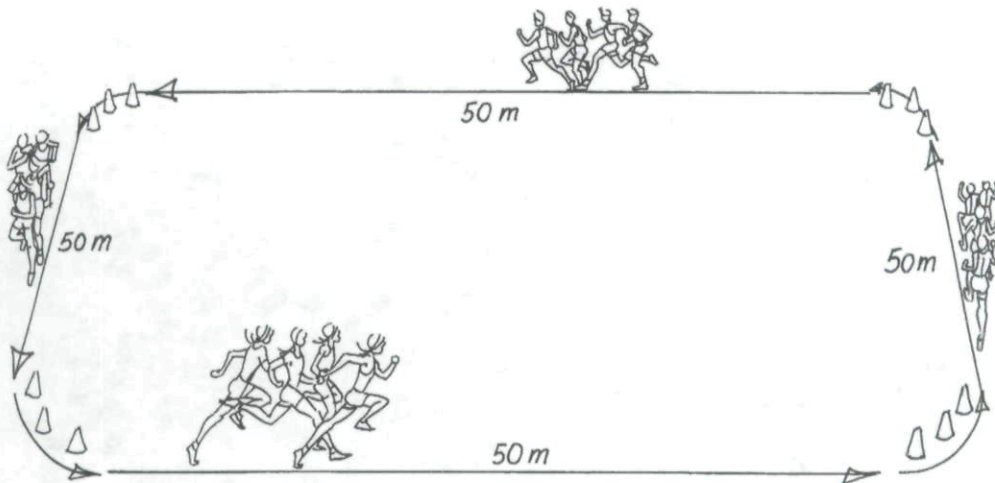
1. Each side is 50 meters or yards; each team begins at a corner (the corners are rounded).
2. Jog on two sides (18 to 20 seconds), walk on two sides (40 to 50 seconds).
3. Alternate walking 50 meters, jogging 50 meters, walking 50 meters, jogging 50 meters.



QUAD

Focus: general endurance

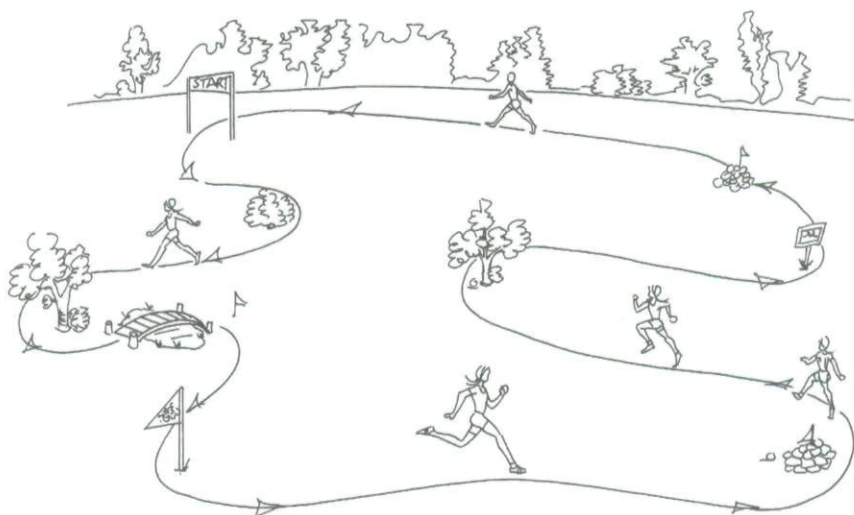
1. Divide athletes into four groups and place them at the four corners.
2. At their own pace (per group or individual child), they walk a segment, run, jog, or brisk walk.
3. They do two to four nonstop loops.



OFF INTO NATURE

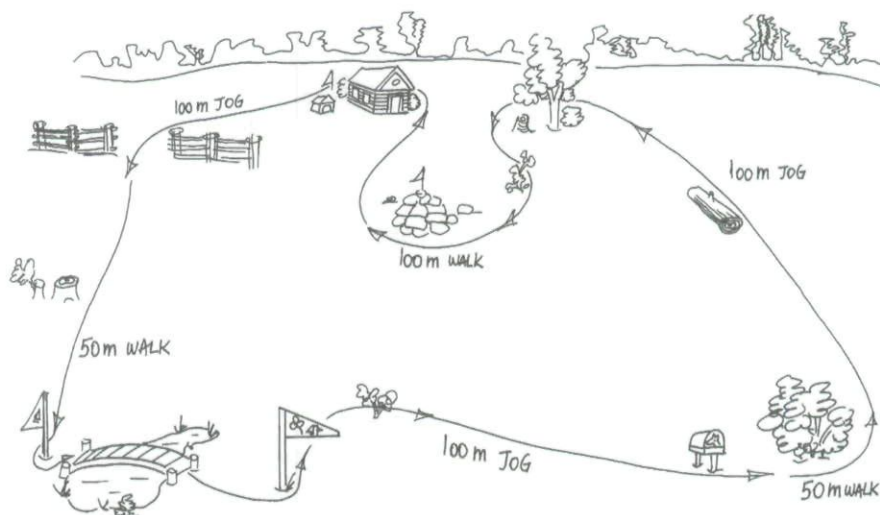
Focus: general endurance

1. Mark a course of 300 to 500 meters (330 to 545 yards) in a natural setting.
2. Divide the course alternately into 100-meter (110-yard) and 50-meter (55-yard) sections using natural landmarks.
3. Walk the 50-meter (55-yard) section and jog the 100-meter (110-yard) section. Each athlete will complete the course two to four times.



Variation

For more advanced athletes, run the whole course but vary the speed of the sections.



Exercises for Puberty

The following five exercises for endurance training are appropriate for puberty athletes.

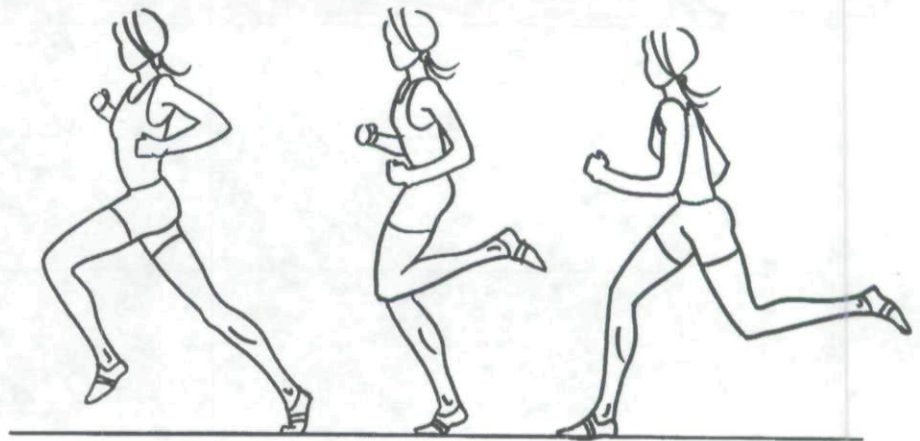
AEROBIC TECHNICAL RUN

Focus: running technique

1. The technique of the distance running step has the following important elements: tall running with the head up, shoulders down and relaxed, arms swinging back and forth in coordination with the leg actions.

2. Knee drive and leg recovery are lower than in sprinting, landing on the heel and rolling over the toe for a new propulsion phase.

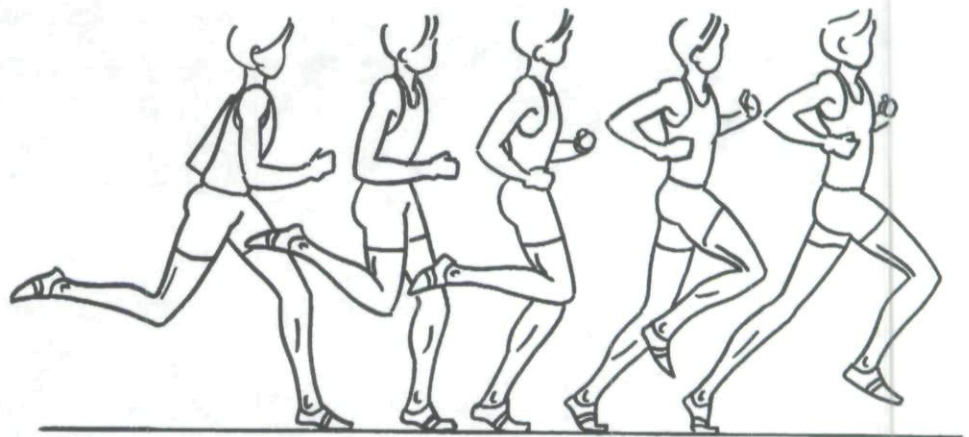
3. Steadiness of running and pace judgment are always important attributes for endurance running.



LONG REPETITIONS FOR PACE JUDGMENT

Focus: aerobic endurance and pace judgment

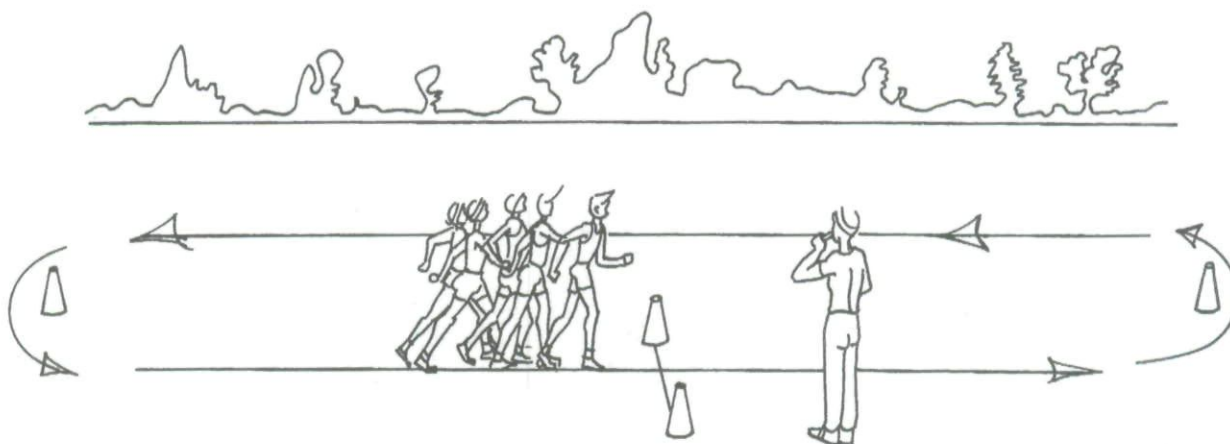
1. Run distances of 800 to 2,000 meters (1.25 miles) in a steady rhythm and even pace (pace judgment). To ensure pace judgment, the instructor can time each repetition and give feedback to the athletes, individually. However, make sure that timing the athletes is not used to create a competitive environment.



INTERVAL TRAINING RUNS

Focus: aerobic and anaerobic endurance

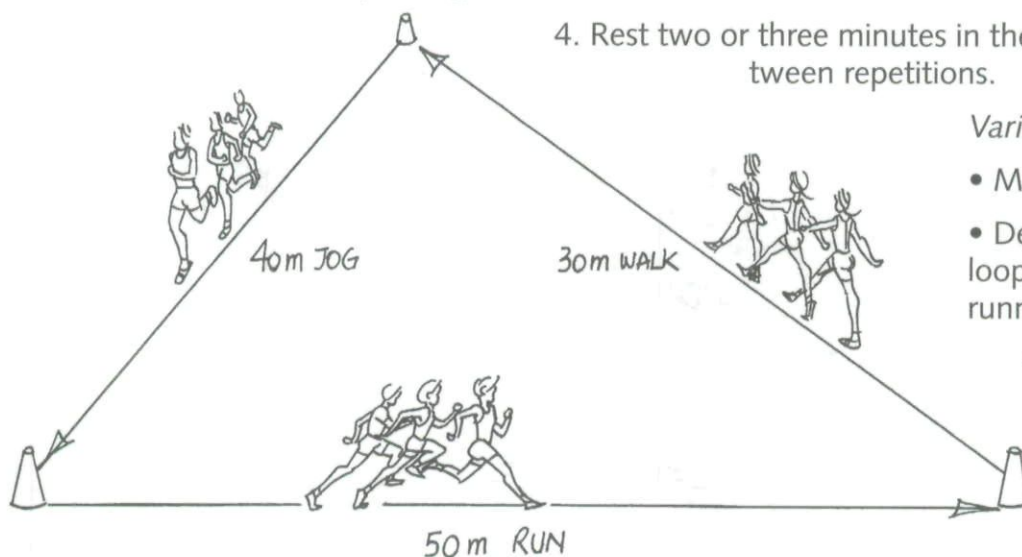
1. On a track, run repetitions of 200 to 400 meters at a medium and even pace.
2. Concentrate on good form, with a relaxed and steady pace.
3. Perform each repetition at the same pace.
4. Do not push yourself. Remember this is medium (60-percent) velocity.



10-MINUTE TRIANGLE RUN

Focus: aerobic endurance

1. Divide the children into three groups, each starting at the corner of the triangle.
2. Individuals can perform a combination of walk, jog, and run, according to their ability.
3. Depending on individual abilities, the same distance can be repeated 2-4 times.
4. Rest two or three minutes in the form of walking between repetitions.



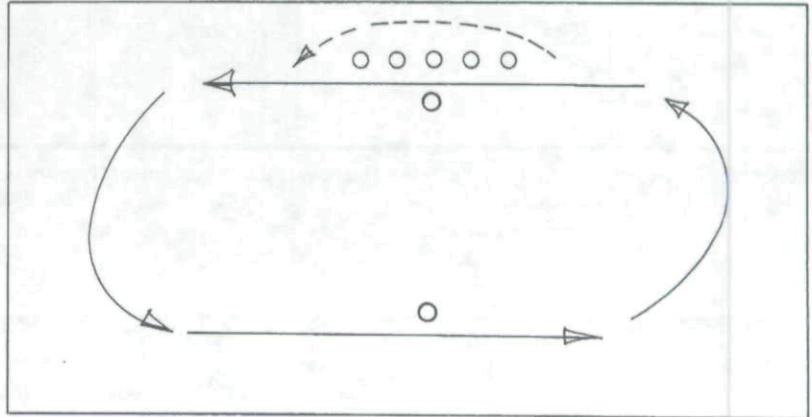
Variations

- Make the triangle larger.
- Decide on a number of loops to perform for jogging, running, and walking.
- Jog for 10 minutes. Run for only 10 minutes. Increase the duration progressively to 12, 15, 20, 30 minutes, and so on.

PASSING ON THE RIGHT

Focus: anaerobic and aerobic endurance

1. Teams start at marked points in an oval of a stadium and run single file.
2. Every 10 steps the last person moves to the front, passing on the right.
3. Every time the runners pass the point of the oval where they started, the instructor blows a whistle to signify the beginning of a sprint.
4. When the instructor blows the whistle again, the runners revert to the initial pace.
5. Continue this for a previously decided number of laps (i.e., 3, 4, or 5).



Exercises for Postpuberty

On the basis of prepuberty and puberty aerobic and anaerobic training, the scope of endurance training for postpuberty is sport specific. Athletes perform most forms of training with the implement (e.g., ball) they use in the chosen sport. Tables 7.4 and 7.5 exemplify the periodization of endurance training for postpuberty. The training program performed in the suggested phases progresses from aerobic (the months of October and November) to a mixed training, in which half of the program is interval training, to develop the anaerobic endurance, while aerobic training continues. During the competitive phase, endurance training is clearly sport specific, with at least 50 percent ergogenesis training.

During the competitive phase, the specific training for aerobic and anaerobic endurance using technical and tactical drills can follow these examples:

- Aerobic training: Specific drills of 90 seconds to 3 minutes or longer
Rest interval of 1 or 2 minutes
Target heart rate of 166 to 174 beats per minute
- Anaerobic training: Specific drills for 20 to 60 seconds (high-intensity drills)
Rest interval of 2 or 3 minutes
Target heart rate of 176 to 186 beats per minute

The coach decides the number of repetitions for each type of drill, depending on athletes' potential and the schedule of games and competitions.

Table 7.4 Periodization for an Annual Plan for Early Postpuberty

Dates	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Training phase	Preparatory								Competitive		T	
Type of training	Aerobic endurance				Aerobic long intervals		Mixed aerobic and anaerobic		Mixed specific endurance, introduce ergogenesis		Aerobic	

Notes: Note the progression regarding the type of training and training content. Types of training change according to the objectives of training phases.
T = Transition.

Table 7.5 Periodization for an Annual Plan for Late Postpuberty

Dates	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Training phase	Preparatory			Competitive		T	Preparatory			Competitive		T
Type of training	Aerobic	Mixed ergo.	Specific endurance ergo.		A	Aerobic	Mixed ergo.	Specific endurance ergo.		A		

Note: A = Aerobic; Ergo. = Ergogenesis.

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