Development of Basic And Special Endurance in Age-Group Swimmers

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Multi-year Training (MYT) is necessary to achieve top international level performances in competitive swimming. The ultimate goal of MYT is the optimal development of motor abilities, functional power, physiological capacities, and movement efficiency. The current age range for top achievements in swimming is 17-20 years for females and 19-22 years for males. Thus, the extent of long-term training should cover a period from 10-12 years since the average age for commencing purposeful training should be 8-9 years for girls and 10-11 years for boys. The duration of MYT may differ between individuals according to the age when they start training and their rate of biological maturation.

In accordance with known patterns of growth and development of motor and psychological abilities, MYT to the time when excellence should be achieved is subdivided into several stages. Each stage has its own objectives primarily determined by the peculiarity of development and maturity. Four stages of MYT are commonly proposed and are the foundation for planning of training for young swimmers (Bulgakova, 1986; Nabatnikova, 1982; Vorontsov, Chebotareva, & Solomatin, 1990).

1. THE STAGE OF PRELIMINARY SPORT PREPARATION

The optimal age to initiate MYT for swimming is 7-9 years for girls and 8-10 years for boys. Beginning earlier will simply increase the total duration and cost of MYT without any significant eventual benefit because of the very slow physical growth and development of children within the age range of 5-8 years. A too-early start also may lead to an early loss of interest in swimming as a competitive sport. The duration of this preliminary sport preparation is 1-2 years.

The Stage of Preliminary Sport Preparation Objectives

- Identification of basic morphological criteria (e.g., body type, proportions, height, weight, buoyancy) and some elementary characteristics of motor talent for swimming.
- Formation of a stable interest toward swimming.
- Learning of basic swimming techniques and a wide variety of motor skills.
- Health improvement.

The important content of this stage is learning basic swimming techniques while employing a large number of preparatory and special exercises with a major accent on enjoyment. The frequency of practices should gradually increase from 3 to 5-6 per week which automatically leads to an increase in the total training load and an increase in both swimming and general physical fitness.

2. THE STAGE OF BASIC TRAINING

The average age to begin the Stage of Basic Training is 9-10 years for girls and 10-11 years for boys. Normally, this stage lasts from 3-4 years.

The Stage of Basic Training Objectives

- Development of general motor abilities and a functional foundation for swimming.
- Identification of the most gifted young swimmers on the basis of morphological criteria, indications of endurance, and pulling strength of a general and specific nature.
- Perfection of technical swimming skills in all strokes with gradual specialization in at least two strokes.
- Formation of a positive attitude toward regular training.

This stage of MYT is the most important for the development of aerobic capabilities of young swimmers. It is characterized by a progressive annual increase in total swimming volume and general physical land-exercises. The total swimming volume in the last year of this stage may reach 1200-1400 km for girls and 1000-1200 km for boys. An analysis of the most successful coaches reveals that optimal workloads in the total training volume include 60-65% aerobic exercises, 25-30% of "mixed" aerobic-anaerobic activities, and 2-3% of anaerobic glycolytic and alactic work.

As swimmers grow, pulling power and speed of swimming during workouts should increase. This is assisted by using additional resistance (e.g., belts, paddles) and stretch cords. Despite a notable increase in aerobic capacity and efficiency, the ability to perform training workloads at the level of maximal oxygen uptake and anaerobic abilities are very limited when compared to older swimmers.

The development of anaerobic abilities is achieved mostly by periodic use of glycolytic and alactic training exercises and an annual increase in the number of competitions. Extensive volumes of high-speed interval training at this stage of MYT are very often accompanied by stress symptoms such as a decrease of general and specific immunity and a higher-than-normal frequency of minor and major illnesses.

It is very important to teach young athletes the proper techniques of strength exercises which employ free weights (e.g., dumbbells, barbells) and pulling devices (e.g., stretch-cords, biokinetic benches, the Vasa swim trainer, pulley weights). The preferred choice to develop muscular power and strengthening of connective tissues (e.g., tendons and ligaments) should be through "natural" motor exercises (e.g., push-ups, chin-ups, squats, sit-ups) which use the individual's body weight as the loading factor. The major emphasis should be on the development of muscular endurance in exercises involving big muscle groups or the whole body. The implementation of different exercises with low resistance and high repetitions promotes muscular endurance. The organization of appropriate training may be circuit training as well as station training. The main benefits of such training are reduction in energy costs and improved regulation of muscle contractions and coordination. It takes a long time to teach young athletes the art of perfect coordination.

Near the end of this stage of MYT it is important to introduce land training exercises with both high and submaximal resistances.

The development of specific pulling force in the water in young swimmers is a very influential factor for forming effective swimming techniques. It is achieved by teaching conscious control of discerning the optimal ratio between stroke rate and stroke distance with an accent on stroke distance.

3. THE STAGE OF SPECIALIZATION

Girl swimmers usually enter this stage between 12-14 years of age whereas boys, who normally lag 1-2 years behind girls because of a difference in maturation rates, enter between 13-15 years of age. The readiness of a young swimmer for increased training demands will be governed by the individual's biological age (level of maturation). Maturation affects morphological growth, motor skill, and functional development. The duration of this stage is 3-4 years.

The Stage of Specialization Objectives

- To raise the general functional level and prepare for maximal training workloads.
- To perfect the technical and tactical skills to autonomic level.
- To develop strong acceptance of and stable motivation toward intensive training and full commitment toward swimming.

At this stage of MYT the preparation of swimmers should become even more individualized. Starting with the onset of puberty, training volumes and intensities may be increased unevenly. Up to the ages of 12-13 years for girls and 14-15 years for boys aerobic training should be accompanied by performance improvements in short as well as long distance races. In contrast, at older ages aerobic training only exerts a direct influence on distance swimming results. Anaerobic power and capacity and strength grow very rapidly in adolescents in concert with muscle mass increase. These factors affect sprint and middle-distance swimming. The rapid growth of muscle mass and glycogen stores, coupled with a rise in secretion of adrenaline and noradrenaline and sexual hormones creates an optimal biological background for development of anaerobic abilities, maximal power, specific muscular endurance, and speed-strength abilities. Consequently, training has to be altered to reflect these developmental changes.

An increase in the volume of anaerobic and strength training at this stage of MYT positively affects the development of special working capability only if a swimmer had performed a significant volume of aerobic training in the earlier stages. A high level of aerobic capacity is an important basis for developing muscular endurance and general resistance to physical stress.

Total training volume in the final year of this stage may reach 1600-1900 km comprised of 65-85% aerobic swimming, 15-30% of mixed glycolytic training, and 5-6% of alactic (sprint) training. The positive transfer to swimming of working ability developed in other types of physical exercises (e.g., running, skiing, rowing) decreases as this stage progresses. The primary stimulus for developing special swimming capability is swimming with good technique.

4. THE STAGE OF EXCELLENCE

The average age to start training to achieve swimming excellence is 15-16 years for girls and 16-19 years for boys. This stage is the opportunity to achieve the ultimate goal of MYT, the maximal level of physical, functional, and motor development which should lead to the realization of maximum performance appropriate for a swimmer's potential.

The Stage of Excellence Objectives

- To master individualized training workloads that will result in high performance levels.
- To maintain a high level of general functional abilities.
- To maximize special functional and motor abilities, and technical and tactical skills.
- To maintain strong motivation toward competing.

During this stage, growth of physical and motor capacities slows with the deceleration of maturation. Eventually, growth and the potential to develop capacities cease. The important factor for further improvements in performance will come from increasing the annual training volume in girls 15-16 years of age and boys 16-18 years of age. If too much training is done in the years prior to these one should not expect most young swimmers to achieve a top international level of performance although some exceptional individuals do. The primary training goal in the Stage of Excellence is mastering maximal swimming volume: 1800-2200 km per year for sprinters, 2200-2600 km for middle distance swimmers, and 2600-3000 km for distance swimmers.

Since the potential to increase training volumes has physiological and time limits, once growth has ceased the perfection of physical condition will be determined by the intensity of swimming and strength training, involvement in training devices such as water flumes, isokinetic machines which create specific regimens of muscle activity, and implementation of advancements in physiotherapy and nutrition.

The proportion of anaerobic work rises to 15-18% of the total training volume with sprint training comprising 3-6%. Another important feature of this stage is the start of full scale intensive strength training which will consume 250-300 hours annually. The nature of strength training also changes. The completion of maturation means that swimmers can withstand large volumes of power training using both high and submaximal resistances. The objective of the land training in this stage is the development of maximal power of specific "swimming" muscles and an increase in local muscular endurance. Strength training in the water should aim to transfer high muscle power developed through land training into high pulling force in all swimming strokes. The strength which swimmers demonstrate on land significantly exceeds pulling force of swimming movements. Special strength training in the water (e.g., tethered swimming with stretch-cords, swimming in the flume at submaximal and maximal speeds with and without stretch-cords, swimming with and without paddles, swimming with elevated pulley weights, swimming with additional drag devices) together with the development of conscious control of the stroke rate to distance ratio help to increase the specific strength abilities of swimmers. Such training also helps swimmers to determine their most appropriate technical characteristics.

ENDURANCE DEVELOPMENT IN YOUNG SWIMMERS

The key factor that supports a high level of special working ability in swimming is *endurance - the ability to perform physical work of a particular intensity without deterioration in its mechanical efficiency despite the accumulation of fatigue*. An endurance background influences the ability to maintain high average speeds of swimming during competitive and training exercises.

The mechanism of aerobic energy supply matures relatively early, its most rapid development occurring during pre-pubertal and early pubertal periods. By contrast, accelerated growth of muscle power and anaerobic abilities occurs at the end of puberty and during post-pubertal adolescence. Therefore, the development of aerobic capacity is of paramount importance for MYT of young swimmers.

Specific regulatory, structural and metabolic changes occur in the human body as result of specific training. The type, intensity, and duration of exercises determine the number of participating muscle groups, ratio of aerobic to anaerobic energy supply, total energy expenditure, and margins of change of physiological constants. In turn, the character of physiological changes during and immediately after exercise determines the type of adaptation.

Knowledge of the relationship between workloads and training effects permits the anticipation of training results at every distinctive stage of preparation. Appropriate classifications of training exercises to develop aerobic and anaerobic abilities in swimmers have been developed as result of number of scientific studies performed in different countries and different laboratories (e.g., Mader & Hollman, 1977; Shirkovets, 1996; Volkov, 1990) as well as resulting from the creativity of advanced coaches. These classifications are based upon relationships between metabolic power of physical work (swimming velocity), distance, heart rate, working level of VO_{2max}, blood pH, and lactic acid level (see Tables 1, 2, and 3). It should be understood that tables of this nature are for adults.

The exercise responses of growing children have some different characteristics to those of adults. Pre-pubertal children respond to demanding exercises primarily be increasing heart rates. Post-pubertal adolescents and in particular adults, respond with both stroke volume and heart rate. The heart rate range to stimulate aerobic adaptation in the majority of children 8-13 years of age is 155-150 bpm. With every year of age the heart rate of children and adolescents decreases at rest as well during submaximal work (Sonkin, 1979, 1985; Ulbrich, 1973). Ulbrich's, 8-year longitudinal study, found that heart rate during submaximal exercise in boys declined steadily from 11 to 18 years of age with the period of most rapid change occurring between 11 and 13 years. Sonkin (1979) found that heart rate at the anaerobic threshold in children 9-10 years of age was 179.0±3.2 bpm, from 12-14 years of age was 161.0±5.7 bpm, and from 16-17 years was 145.0±7.0 bpm.

These studies clearly illustrate the alteration of heart rates with age. Table 4 lists amended heart rates which accommodate the age differences at various levels of endurance training for young swimmers.

The heart rates depicted are for training "average" swimmers maturing at a normal rate probably comprising 50-60% of young swimmers in every chronological age-group. When planning training for young swimmers a coach should consider not only the length and number of repeats, training speed, and heart rate but biological maturity, levels of aerobic and anaerobic capacities, adaptability to workloads of different types, and swimming skill. These contribute to the individuality of the response to exercise. However, training groups for age-group programs usually are formed on the basis of chronological age. It is better to divide squads in streams based on individual abilities and maturity. Especially gifted young swimmers can train with swimmers of "older" age groups and similar performance standards.

Table 1. Zones of Metabolic Power and Their Descriptions.

Zones of Metabolic Power	Descriptions of Pertinent Factors
Aerobic-1	Zone of "aerobic threshold." Continuous work of low intensity and long duration (30 min - 2-3 hr). The source of energy is lipids (fat). Work is performed almost entirely by slow-twitch muscle fibers.
Aerobic-2	Zone of anaerobic threshold - activation of fast-twitch muscle fibers, but prevailing type of ATP replenishment still is aerobic. Sources of energy are lipids and glycogen.
Aerobic-Anaerobic	Zone of carbohydrate metabolism. Aerobic glycolysis provides 70-80% of total energy supply. Bypass product of aerobic glycolysis - pyruvic acid is used in Krebs' cycle in mitochondria. Anaerobic glycolysis provides 30-20% of energy.
Anaerobic-Aerobic	Work is performed at the level of VO_{2max}. The proportion of anaerobic glycolysis in total energy supply is about 40-50%. The main source of energy is glycogen stored in muscles and liver. Significant production of lactic acid during exercise but aerobic energy supply still prevails. Dynamic work of "middle" duration, involving all muscle groups.
Glycolysis-A	Zone of glycolytic "capacity". Work is performed mostly through glycolysis and maximal cardiorespiratory activity. Duration of exercise or single repetition in a set is 1-3 min.
Glycolysis-B	Performance at near maximal glycolytic power with aerobic component quite low. Duration of a single training repetition is 30 sec to 1.5 min.
Glycolysis-C	Zone of maximal glycolysis. Performance at expense of both power and capacity of glycolysis. Mainly "split sets" with duration of an item being 30 sec to 2 minutes but at maximal and supra-maximal swimming speeds.
Alactic Creatine-Phosphate	Short-time maximal effort exercises (maximal mechanical power and movement frequency). Source of energy -- break-down of Creatine Phosphate. Duration of a single effort is 5-20 sec with occasional 30 sec efforts. Heart rate, VO_2 and lactate do not achieve high values since the time of effort is very short.

Table 2. Characteristics of Zones of Metabolic Power.

Zones of Metabolic Power	Heart Rate Range (bpm)	$\%VO_{2max}$	pH	Lactic Acid (mmol/l)
Aerobic-1	120-140	50-60%	7.42 - 7.40	0.9 - 2.0
Aerobic-2	140-160	60-70%	7.40 - 7.38	2.0 - 4.0
Aerobic-Anaerobic	160-170	70-90%	7.37 - 7.33	4.0 - 8.0
Anaerobic-Aerobic	170-180	90-100%	7.32 - 7.28	8.0 - 10.0M
Glycolysis-A	185-190 (200)	75-85% (O_2-demand 110-120%)	7.27 - 7.20	9.0 - 13.0M
Glycolysis-B	190-210	60-70% (O_2-demand 120-130%)	7.20 - 7.14	12.0 - 16.0
Glycolysis-C	210-230 and above	50-60% (O_2-demand up to 140%)	7.14 - 6.95	14.0 - 20.0 (up to 26)
Alactic Creatine-Phosphate	Not appropriate	Not appropriate	Not appropriate	Not appropriate

Table 3. Examples of Training Items for Zones of Metabolic Power.

Zones of Metabolic Power	Examples of Training Items
Aerobic-1	30-min swim; 1-hour swim; 2, 3, 5, 10 km continuous swim; long interval sets such as 40-100 x 100 m.
Aerobic-2	40-60 x 50 m on 50 sec; 3-5 x 800-1000 m; 15 x 300 m;10 x 400 m; 30-40 x 100 m (mostly at 1500 m race pace).
Aerobic-Anaerobic	20-30 x 50 m on 45-60 sec; 3-6 x (6 x 100 m on 1.20-1.30); 10-20 x 150-200 m; 6-10 x 400 m; 2-3 x 800-1000 m (mostly at 800-1500 m race pace).
Anaerobic-Aerobic	4-8 x 300-400 m; 8-15 x 150-200 m; 800+400+200+200+100+100 m; 8 x 50 m + 4 x 100 m +2 x 200 m + 400 m + 2 x 200 m + 4 x 100 m + 8 x 50 m; (mostly at 400-800 m race pace); exercises with step-by-step increase of swimming speed - 15 x 200 m; 4-5 x (4-6 x 100 m).
Glycolysis-A	10-12 x 100 m on 1.10-1.20; 5-8 x 200 m on 2.20-2.40; 4-6 x (6-8 x 50 m) on 35-45 sec; 4-6 x 300 m on 3.40-3.50 (mostly at 200-400 m race pace).
Glycolysis-B	6-10 x 75-100 m on 3-4 min; 16-20 x 50 m on 1.30-2 min; 3-6 x 200 m on 4-5 min; 5-8 x (50+50 m i=5-10 sec) rest=4-5 min; (mostly at 100-200 m

Table 3. Examples of Training Items for Zones of Metabolic Power.

Zones of Metabolic Power	Examples of Training Items
	race pace).
Glycolysis-C	1-5 x (4 x 50 m i = 15 sec) rest=3-6 min; 5-8 x (4-8 x 25 m i = 5-7 sec) rest=4-5 min; 3-5 x (100+50 m i = 7-10 sec); 2-4 x (6 x 50 m i =5-7 sec) rest=3-5 min; competitive races of 200-400 m.
Alactic Creatine-Phosphate	Fastest speed possible; hyper-rating sets; hyper-stroke distance sets; allow full recovery between repetitions; cease when performance decreases.

Table 4. Zones of Metabolic Power and Heart Rates for Endurance Training of Young Swimmers 9-15 Years of Age.

Years	Aerobic-1 TR-1a	Aerobic-2 TR-1b	Aerobic - Anaerobic TR-2	Anaerobic - Aerobic TR-3	Glycolytic (A, B, C) TR-4
9-11	140-155	155-170	170-185	185-200	above 200
12-13	140-150	150-160	160-170	170-190	above 190
14-15	130-140	140-150	150-165	165-185	above 185

Note: TR-5, the zone of alactic creatine-phosphate metabolism is not included in this table because it is inappropriate to regard its work intensity in terms of heart rate.

The scientifically based classification of training exercises shown above proposes eight training categories or zones of metabolic power for adults. For practitioners who work with age-group swimmers, it is more convenient to subdivide training exercises on the basis of working ability composed of power, capacity, and efficiency. From that viewpoint the theory and methods of age-group endurance swimming training can be subdivided into the four categories listed below.

1. **The development of "slow " aerobic endurance or basic endurance-1 (BE-1).** This develops endurance for extensive workloads at speeds appropriate for aerobic and anaerobic thresholds. It is meant to develop aerobic capacity and movement efficiency. This group includes exercises from aerobic-1, aerobic-2, and aerobic-anaerobic zones in the adult classification (see Tables 1, 2, and 3). Work is performed mostly by slow-twitch muscle fibers, but fast-twitch fibers are activated if training speeds are increased.
2. **The development of "fast" aerobic endurance or basic endurance-2 (BE-2).** Endurance for workloads requiring maximal aerobic effort are developed. This work is accompanied by significant contributions of anaerobic energy and accumulation of lactic acid. In children aged 7-9 years at VO_{2max} blood lactate

reaches a level of 7-8 mmol/l. The work is produced by both slow- and fast-twitch oxidative fibers. Some fast-twitch fibers derive energy from glycolysis.

3. **The development of special (anaerobic-glycolytic) endurance (SPE).** Work of a duration ranging from 30 sec to 2-3.5 min is performed in these exercises. Anaerobic glycolysis is the primary mechanism of ATP replenishment. High levels of lactate accumulate. This work requires great effort and as well as all slow-twitch fibers, involves the majority of fast-twitch glycolytic and oxidative muscle fibers.
4. **The development of speed-endurance (anaerobic-alactic) endurance (SPDE).** Work of the utmost intensity and energy use is sustained for very short periods. It is performed using intra-muscular stores of creatine-phosphokinase. Fibers of all types are fully used. The ability to maintain maximum speed is determined by muscle composition (the ratio of fast-twitch oxidative and glycolytic fibers to slow-twitch oxidative fibers) as well as by the power and endurance of fast-twitch fibers.

These four categories are more appropriate for MYT of young swimmers. They do not exclude the use of the more-detailed adult-oriented classification scheme but better accommodate the distinct aerobic abilities of the pre-adult swimmer.

THE DEVELOPMENT OF BASIC ENDURANCE-1

The development of aerobic endurance for low intensity activity (BE-1) is achieved by continuous cyclical activities such as swimming, running, skiing, rowing, walking, and cycling.

With a gradual increase from practice to practice of the number of exercises, number of repeats, frequency of movements, and training sessions sport games and general fitness exercise increase in their potential to develop BE-1. The intensity (speed) of the exercise may be less than or about anaerobic threshold, but significantly lower than critical performance intensity. Exercises belonging to the first three zones of adult metabolic power are suitable and heart rate ranges for TR-1a and TR-1b in Table 4 are applicable for age-group swimmers.

General fitness exercises and cyclical motor activities are efficient for the development of BE-1 in girls younger than 12-13 years and boys younger 13-14 years because up to those ages there is still positive transfer of endurance between different types of continuous activities into swimming. The purpose and effects of such exercises in mature swimmers is much different. They are performed in the early stages of basic training to develop general fitness upon which late specialized training can be superimposed.

Swimming training for developing BE-1 includes distance swimming with constant or variable speed from 800-1000 m up to 2000-3000 m, and extensive interval training using middle (300, 400, 500, 600 m) as well as short (25, 50, 100, 150, 200 m) distances. Training of this type increases capillary and mitochondria density in the major working muscles, coordination of movements, and improved circulation. The ability of muscle fibers to use fat as fuel and to be oxidative is increased. Slight increases in swimming speed but greater capacity to sustain those speeds result.

Development of BE-1 is a major form of training for young swimmers 8-11 years of age. They perform exercises for development of BE-1 with longer rest intervals between repeats (from 30-60 sec). Better recovery is facilitated and swimmers should concentrate on smooth movements using correct skill elements. Longer pauses also allow for more coaching to occur. As the ages of swimmers increase rest intervals should be shortened and total swimming distance increased in order to provide added overload and stimulation. For all swimmers development of BE-1 is best accomplished by using front and back crawl and breaststroke as well as pulling and some kicking.

A high level of BE-1 is a very important base for training BE-2, the ability to perform physical work demanding maximal aerobic power. Its development in younger age-group swimmers is accompanied by improvement in short distance speeds due to better regulation of physiological systems and economy of energy expenditure.

DEVELOPMENT OF BASIC ENDURANCE-2.

Basic Endurance-2 (BE-2) is the endurance for physical work demanding maximum strain on the oxygen delivery systems. It is accompanied by significant contributions of anaerobic energy. Characteristics of BE-2 training are listed below.

- Maximal oxygen uptake (VO_{2max}) during laboratory or field testing.
- Near maximal working level of O_2 uptake during specific training exercises.
- Of a duration that allows an athlete to retain O_2 uptake at near maximal level.
- Blood lactate level sustained when aerobic work is at a maximum (6-7 mmol/l in children 7-9 years of age and 7-9 mmol/l in adolescents 15-16 years of age).
- Heart rates according to age-groups (TR-3 in Table 4).

The objectives of training are:

- To increase VO_{2max}.
- To increase the ability to maintain VO_2 uptake near maximum for longer periods.
- To excel at the mechanical efficiency of movements at this level of effort.
- To perform more aerobically at a given percentage of VO_{2max} (less blood lactate accumulation).

The development of BE-2 is achieved in adults using exercises and heart rates in the anaerobic-aerobic zone of metabolic power (see Tables 1, 2, and 3). The total duration of an exercise or interval set should be between 10-30 min.

Activities to develop BE-2 in pre-pubescent and pubescent children (ages 8-12 years in girls; 10-13 years in boys) are cross country running and skiing, rowing, circuit training with moderate resistance, and swimming. Land aerobic training may be even more beneficial for young swimmers in these age-groups because of inefficient swimming techniques.

Development of BE-2 during swimming can be achieved through interval-distance training (e.g., 2-4 x 800-1000 m); maximum effort repetition training over middle and long distances (n x 300-500 m; n x 800 m; n x 1500 m with rest intervals 1.5-3 min); intensive interval training over repetition distances of length 200, 300, and 400 m and interval training with shorter distances (e.g., 25, 50, 100, 150 m) and more repetitions per set and shorter rest intervals (e.g., 60-80 x 25 m rest = 5-10 sec; 30-40 x 50 m rest = 10-15 sec; 16-20 x 150m, etc.).

In children 8-11 years of age it is normal to use repetitions of short and middle length (25, 50, 100, 150, 200 m) because they generally cannot sustain stable and efficient swimming techniques over longer distances. That restricts their ability to maintain needed intensity for long enough to achieve the desired training effect.

A practical measure of maximal aerobic development is a long interval set consisting of middle-distances with progressive increases in intensity (swimming speed). The set is subdivided into stages, each successive stage being performed with greater intensity and heart frequency. For example, an interval set of 15 x 200 m should be divided into five stages:

1. 3 x 200 m performed at 60-70% of maximal speed.
2. 3 x 200 m performed at 70-75% of maximal speed.
3. 3 x 200 m performed at 75-80% of maximal speed.
4. 3 x 200 m performed at 80-85% of maximal speed.
5. 3 x 200 m performed at 85-95% of maximal speed.

Gradual, stage increases of work intensity are necessary to achieve the maximal level of oxygen uptake. There are important rule alternatives for training sets designed to develop BE-2.

- Maintain a high but even swimming speed during the first part of the set. Then increase intensity even more during second part.
- Increase swimming speed by even increments from lap to lap or stage-by-stage.
- For a continuous distance swim, negatively split the swim by swimming the second part considerably faster than the first.

These rules are effective only if the last half of the training task is performed with a heart rate 170-190 bpm (the anaerobic-aerobic metabolic zone for adults and TR-3 in Table 4 for age-group swimmers).

Progressive intensity exercises facilitate technique and tactics development in concert with functional development in young swimmers. It is a good opportunity to teach stroke control and to learn the differences between levels of intensity.

During the growth period, the proportion in the total training volume of repeat training and relatively intense interval training increases. Nevertheless, "tough" training tasks (near maximal intensity, heart rates 180-190 bpm; rest intervals from 5-15 sec) should be used very cautiously until the ages of 13-14 years in girls and 14-15 years in boys. More recovery and a consistent working intensity with efficient technique are fostered by rest intervals ranging from 20-40 sec.

It should be noted that too frequent and much volume of training tasks demanding maximal mobilization of cardiorespiratory system may cause exhaustion of the heart muscle and central nervous system in young swimmers. Swimmers who are entering puberty are most sensitive to excessive training. It has been estimated that from 20-35% of pubescent girls and boys demonstrate a non-harmonic type of development with growth and development of functional systems lagging far behind somatic growth. This requires an assessment of biological age and medical monitoring of pubescent athletes during a training season. This stage of development requires the coach to exercise the utmost care while monitoring training responses and recovery.

DEVELOPMENT OF ANAEROBIC ENDURANCE

Development of anaerobic endurance (SPE) is a major objective of training. In this stage the objectives are as follows.

- To increase the power, capacity, and efficiency of anaerobic glycolysis.
- To enhance resistance to significant disturbances of homeostasis due to lactate, CO_2, and other metabolite accumulations.
- To improve the retention of the optimal ratio between stroke distance and stroke rate in fatigued states.

SPE is developed using swimming training exercises in the glycolytic A-B-C metabolic zone for adults and TR-4 (see Table 4) for children, and intense land exercises aimed at developing strength particularly through pulling and simulation activities. Appropriate land training would be circuit training with moderate to submaximal resistances and exercise rates which approximately match swimming stroke frequencies. Work periods should range between 30 sec and 2 min.

Heart rates indicate the work intensity for developing this feature. Once again, technique is very important and should be stressed particularly in fatigue. In younger swimmers (7-11 years) kicking is also an effective training activity.

Activities to develop SPE are as follows:

- Competitive swimming of all distances, including long distances, and all strokes.
- High intensity interval training ("fast interval training") using short (25, 50, 75, 100 m) and middle-distance (150, 200, 300, 400 m) repetitions with rest intervals as much as 1.5-3 times longer than the time of a single repeat.
- Repeat-interval sets ("split" sets). For long distance training examples are:

  - 1-3 x (8-15 x 100m ; rest intervals i=5-20 sec);
  - 1-3 x (4 x 200 m i=5-20 sec) with 5-8 min active rest between sets;
  - 5-10 x (4 x 100 m i=5-15 sec) with 3-7 min rests between sets;
- For middle and short distance training examples are:
  - 1-5 x (4 x 100 m or 8 x 50 m with i 5-10 sec);
  - 3-8 x (4 x 25 m i=5-10 sec);
  - 2-8 x (50+50 m i=5 -10 sec);
  - 4-6 x (4 x 50 m or 100+50+50 m i=5-15 sec) with 4-6 min rests between sets.

For young swimmers 7-11 years of age the major form of development of anaerobic abilities and SPE are competitions themselves (distances 50, 100, 200 m) and swimming "short" sets such as 4-8 x 25-50 m or 2-6 x 100 m with maximal intensity.

Starting with the age 13-14 years for girls and 15-16 years for boys, strength training becomes a powerful way to simultaneously develop anaerobic abilities and the strength of pulling muscles. For some young individuals, strength and swimming training may be even more productive for rapid improvement than only swimming. For parallel development of SPE and strength on land, stretch-cords, pulling devices like the Vasa Swim Trainer, Huttel-Mertens device, pulley weights, isokinetic devices (Mini-Gym, Biokinetic), frictional devices, trolleys on inclined surface, etc. may be used.

DEVELOPMENT OF ANAEROBIC-ALACTIC ENDURANCE

Development of anaerobic-alactic endurance ("speed endurance" SPDE) requires exercises which mainly affect intra-muscle energy release (creatine-phosphokinase reaction - the alactic mechanism). These train the highest metabolic power zone.

The principal factors which train this form of endurance are maximal working power and frequency of movements coupled with maximal nervous concentration during performance of each effort. Since the duration of working periods is very short, from 5-30 sec, maximal heart rates cannot be achieved. Thus, the main criteria to evaluate this ability are swimming speed during sprint efforts or movement frequencies during the execution of maximal efforts with near maximal resistances (in and out of the water).

To develop SPDE 2-16 repetitions should be performed over distances ranging from 10-30 m. Distances of 50 m can be considered if rest intervals range from 3-5 min. As with all age-group swimming, this type of training should be conducted with conscious control of stroke rate and stroke distance. The ability to alternate stroke parameters during maximal or submaximal swimming, thus controlling stroke efficiency and accumulation of fatigue, is very important for the future progress of young swimmers. This technical skill should be learned in the very early stages of MYT.

A variation for training SPDE is to use a very great number of repetitions (40-80 x 15-25 m) with inter-trial rest intervals of 40-60 sec. Recently, this has been shown to be a very popular activity in the preparation of many world class swimmers. It affects anaerobic glycolytic abilities and may be used to prepare young swimmers after 12-13 years of age in girls and 14-15 years of age in boys.

Heart rates are not particularly important for monitoring the development of this factor. However, for age-group swimmers they will range in the TR-5 category but performance intensity (swimming speed) still must remain the major adaptation criterion.

EXERCISES FREQUENTLY USED FOR DEVELOPING ENDURANCE IN AGE-GROUP SWIMMERS

During maturation, notable and uneven changes in physical abilities, motor skills, and adaptive reserves occur in young swimmers. Therefore, training methods, volume, and intensity used for developing distinct types of endurance also should be changed in accordance with growth rate and maturity factors and trends.

Below are suggestions for basic swimming exercises that could be used for the development of the four different types of endurance in young swimmers of different ages.

In the examples, abbreviations are used. They are listed below.*

Glossary

Term	Meaning
CRD	swimming with full coordination
K	swimming using leg kick only
P	swimming using arm pull only
TR-1, TR-2, TR-3, TR-4	training categories based upon heart rates (see Table 4): TR-1 relates to both TR-1a and TR-1b.
i	rest intervals between swims in interval sets
rest	rest duration between sets in repeated-interval sets
FR	free style (front crawl)
BK	backstroke
BR	breaststroke
BF	butterfly
IM	individual medley
"	indicates seconds
'	indicates minutes

* If a swimming stroke is not designated, the exercise can be executed using free style or a swimmer's specialized stroke (other than butterfly).

AGE 8-9 YEARS*

*The age applies to the beginning of a swimming year.

Development of BE-1 (TR-1 and TR-2)

16-40 x 25 i= 5-10 " - FR, BK, BR (CRD, P or K) with conscious control of swimming technique (TR-1, TR-2);

16-20 x 50 CRD, P, K i=10"-15";

8-12 x 100 CRD, P, K i=20-30";

6-8 x 150-200 CRD, P, K i=20-40";

1-3 x 400 (TR-1); 1 x 800-1000.

Development of BE-2 (TR-3)

16-20 x 25 i=15-30";

10-20 x 50 CRD, P, K i=30-40";

8-20 x 50 (50 CRD + 50 K) i=20-40";

8-10 x 50 K i=30-40";

5-10 x 100 (75 CRD + 25 K) i=40-60";

5-10 x 100 K i=30-60";

8-12 x 100 IM i=20-40";

3-5 x 200 K i=40-60".

Development of SPE (TR-4)

4-16 x 25 CRD, K i=30-60";

4-6 x 50 FR, K i=60-90";

1-3 x 100 CRD i=2'-3'.

Development of SPDE (TR-5)

10-20 x 10-15 CRD, P, K i=30-40";

4-8 x 25 CRD, P, K i=40-60".

AGE 10 YEARS

Development of BE-1

16-30 x 50 (TR-1, 2), i=20"-30";

8-12 x 100 (TR-1, 2), i=30"-40";

5-8 x 150-200 i=60"-90";

3-5 x 300-400 (TR-1) i=2'-3';

1-3 x 600-800 (TR-1) i=2'-4';

1-2 x 1000 i=2'-4';

8-16 x 50 K (TR-2) i=20"-30";

8-12 x 100 K (TR-1, 2) i=30"-40";

16-30 x 50 (50 CRD + 50 K TR-2) i=20"-40";

4-6 x 200 K (TR-1, 2) i=30"-40";

16-30 x 25 CRD, P, K (TR-2), with conscious control of technique, i=15"-30";

1-3 x 400 IM (change stroke every 25 or 50 m) i=60"-90";

1-2 x 400 K i=40"-60".

Development of BE-2

20-30 x 25 CRD, K i=15"-20";

16-30 x 50 i=15"-30";

6-10 x 100 i=30"-40";

2-4 x 200 i=40"-90";

2-4 x 400 i=40"-1'20";

10-16 x 50 K i=20"-30";

8-16 x 50 BF i=20"-40";

4-8 x 100 BF i=30"-40";

3-6 x 200 (50 BF + 50 FR) i=40"-90";

6-12 x 100 (75 CRD + 25 K) i=30"-40".

Development of SPE

2-6 x 50 i=1'-2';

10-12 x 25 CRD, K i=30"-40";

1-5 x (4 x 25 i=15"-30") rest=3'-5';

1-4 x 100 i=2'-4';

1-3 x 200 i=4'-6'.

Development of SPDE

10-30 x 10-15 CRD, K i=30"-60";

6-10 x 25 CRD, K i=40"-90".

AGE 11 YEARS

Development of BE-1

20-40 x 25 all strokes CRD, P, K i=10"-20";

16-30 x 50 i=15"-30" (TR-2);

10-16 x 100 i=20"-40" (TR-1, 2);

4-8 x 150-200 i=20"-40" (TR-1, 2);

3-5 x 300-400 i=40"-90" (TR-1, 2);

1-3 x 800-1000 i=3'-5' (TR-1);

3-8 x 200 IM i=30"-60" (TR-1);

6-10 x 100 IM i=20"-30" (TR-1);

3-6 x 200 (25 BF + 25 FR) i=20"-40";

1-2 x 400 (25 BF + 25 FR) i=2'-3';

800 K (TR-1);

1-2 x 400 K i=2'-4' (TR-1, 2);

1 x 1500-2000 (TR-1);

800+400+200+100 specialized stroke i=60"-90";

800+400+200+100 IM (change stroke every 25 m) i=60"-90";

1-3 x 800 IM (change stroke every 25 or 50 m) i=90"-3';

1-4 x 400 IM (change stroke every 25-50 m) i=30"-60".

Development of BE-2

10-20 x 50 i=20"-40";

16-30 x 25 CRD, K, P i=30"-60";

2-5 x (4-5 x 100 i=20"-30") rest=2'-3';

4-8 x 200 i=20"-30";

6-12 x 100 i=30"-60";

1-4 x 300-400 i=1'-2';

1 x 800-1000 (FR or IM);

10-16 x 50 BF i=20"-40";

4-8 x 100 BF i=40"-90";

2-5 x 200 BF i=40"-90";

1 x 400 BF (or 400 : 50 BF + 50 FR);

10-16 x 100 K i=20"-40";

3-6 x 200 K i=30"-60".

Development of SPE

12-20 x 25 CRD, K i=30"-40";

4-12 x 50 i=1'-2';

3-6 x (4 x 25 i=15"-30") rest=2'-4';

2-4 x (50+50 i=15"-30") rest=3-4';

1-3 x (4-6 x 50 i=15"-30");

3-8 x 100 i=2'-3';

4-10 x 50 K i=30-60";

3-6 x 100 K i=60-90";

1-4 x 200 K i=2'-4';

4-6 x 100 BF i=1'30"-2';

3-4 x 200 BF i = 2'-3';

3-4 x (4 x 50 IM i=20-30") rest=2'-4';

6-10 x 100 IM rest=1'30"-3';

5 x 200 BF, BK, BR, FR, IM i=4'-5';

2-4 x 150-200 i=2'-4';

400+200+200+100+100+50+50 i=3'-3'-3'-2'-2'-1';

50+100+150+200+150+100+50 i=1'-2'-2'-2'-2'-1';

Development of SPDE

8-16 x 25 CRD, K i=40"-90";

20-30 x 15-20 CRD, K i=20"-40";

2-6 x 30-40 CRD, K i=1'-3';

Tethered swimming using elastic stretch-cords: 15-20 x 12-20 swimming cycles i=30"-40".

Beginning with the age of 11-12 years, swimmers may be introduced to "hypoxic training" or "hypoxic breathing patterns" - breathing every 3rd-9th stroke or cycle. It is expected that the exercises with "hypoxic breathing patterns" performed with relatively slow swimming speed should cause a deeper physiological response from the cardiorespiratory system than the same exercises performed with "normal" breathing pattern.

It is recommended that "hypoxic training" be used in training young swimmers for categories BE-1 and BE-2.

AGE 12 YEARS

(For girls with accelerated biological development start with the age of 11 years)

Development of BE-1

30-40 x 25 any stroke, CRD, P, K i=10'-20";

20-40 x 50 i=15"-20" (TR-1, 2);

15-20 x 100 i=20"-30" (TR-1, 2);

8-12 x 150-200 i=20"-40" (TR-1, 2);

4-8x 300-400 i=30"-60" (TR-1, 2);

2-4 x 800-1000 i=1'-2' (TR-1, 2);

1-2 x 1500-2000 i=3'-4';

1 x 3000;

20-30 x 50 K i=10"-20";

10-20 x 100 K, P i=15"-30";

4-8 x 200 K, P i=20"-30";

1-2 x 400 K i=1'-2';

6-12 x 200 IM i=20"-30" (TR-2);

10-20 x 100 IM i=20"-30" (TR-2);

3-8 x 200 K-IM i=20"-30" (TR-2);

1-3 x 400 K-IM i=40"-60" (TR-1,2);

1 x 800-1500 K, P;

2-3 x 800 IM (change stroke every 25, 50, or 100 m) i=2'-3' (TR-1, 2);

3-6 x 400 IM (change stroke every 25, 50, or 100 m) i=1'-3' (TR-1, 2).

Development of BE-2

40-60 x 25 i=10"-15";

16-30 x 50 i=20"-30";

10-16 x 100 i=20"-40";

4-10 x 150-200 i=40"-90";

2-4 x 300-400 i=40"-120";

1-2 x 800-1000 i=1'30"-2';

1 x 800 IM (change stroke every 25, 50 m)

1 x 1500-2000;

4-8 x 200 IM i=40"-2';

8-12 x 100 IM i=30"-60";

20 x 50 IM i=15"-20";

20 x 50 BF i=20";

1 x 800 (25-50 BF/ 25-50 FR);

1-3 x 400 (50 BF/50 FR);

2-3 x 400 BF i=50"-90";

6-10 x 150 BF i=40"-90";

2-6 x 200 BF i=40"-90";

8-15 x 100 BF i=30"-60";

16-20 x 50 K i=20"-30";

8-12 x 100 K i=30"-40";

4-6 x 200 K i=40"-60";

1-2 x 400 K i=2'-3';

2-4 x 400 IM (change stroke every 25, 50 m) i=3'-4'.

Development of SPE

20-30 x 25 CRD, K, P i=30"-40";

2-3 x (4 x 25 i=10"-20") rest=3'-4';

8-16 x 50 CRD, K i=40"-90";

4-8 x 100 i=1'30"-3';

3-5 x 200 i=2'-4';

4-6 x (50+50 i=7"-10") rest=3'-5';

4-6 x (4-6 x 50 i=10"-15") rest=3'-5';

2 x (4 x 100 i=15"-20") rest=3'-5';

4-8 x 75 i=2'-3';

2-3 x 400 i=3'-5';

400+2 x 200+4 x 100+8 x 50 i=3'-2'-2'-2'-1';

2-3 x (4 x 50+2 x 100+200) i=30"-90";

6-16 x 50 BF i=40"-60";

4-8 x 100 BF i=1'-3';

1-3 x 200 BF i=2'-3';

1 x 400 BF;

1-2 x 400 IM (change stroke every 50) i=3'-5';

3-5 x 200 IM i=1'30"-4';

8-12 x 100 IM i=1'-3';

16-20 x 50 IM i=40"-90";

3-5 x (4 x 50 IM i=10"-15") rest=3'-5';

4-6 x (4 x 25 IM i=5"-15") rest=2'-4';

8-16 x 50 K i=40"-60";

5-10 x 100 K i=1'-2';

3-5 x 200 K i=1'30"-3';

1 x 400 K;

400+200+200+100+100+50+50 i=3'-3'-3'-2'-2'-1';

Development of SPDE

10-16 x 25 CRD, K i=45"-90";

15-30 x 15-20 i=30"-60";

3-8 x 30-40 i=1'30"-2'.

AGE 13 YEARS

(For girls with accelerated biological development start with the age of 12 years)

Development of BE-1

30-60 x 25 any stroke, CRD, P, K i=10"-15";

20-40 x 50 CRD, P, K i=15"-20" (TR-1, 2);

20-30 x 100 i=15"-30" (TR-1, 2);

15-20 x 150-200 i=20"-40" (TR-1, 2);

6-10 x 300-400 i=30"-60" (TR-1, 2);

3-4 x 800-1000 i=1'-2';

1-3 x 1500 i=2'-3';

1 x 2000-3000 (TR-1)

20-30 x 50 K i=15"-20" (TR-2);

16-20 x 100 K i=20"-30" (TR-1, 2);

5-8 x 150-200 K i=20"-30" (TR-1, 2);

1-3 x 300-400 K i=30"-60" (TR-1, 2);

1 x 800-1500 K (TR-1);

4-8 x 200 BF i=30"-40" (TR-2);

20-30 x 50 BF i=20"-30"(TR-2);

10-16 x 100 BF i=30"-40"(TR-2);

10-15 x 200 IM i=15"-30";

10-20 x 100 IM i=15"-30";

2-4 x 800 IM (change stroke every 25-50-100 m) i=1'-2';

4-6 x 400 IM (change stroke every 25-50-100 m) i=30"-60".

Development of BE-2

20-30 x 50 i=20-40";

16-20 x 100 i=30"-40";

8-12 x 150-200 i=30"-90";

4-8 x 300-400 i=60"-90";

2-3 x 800-1000 i=2'-3';

1 x 1500-2000;

20-30 x 50 K i=30"-40";

10-16 x 100 K i=30"-60";

3-6 x 150-200 K i=30"-40";

1-2 x 300-400 K i=2'-3';

12-20 x 50 BF i=30"-40";

8-15 x 100 BF i=30"-60";

3-6 x 200 BF i=40"-90";

1-3 x 400 BF i=40"-60";

1 x 800 (50 BF/50 FR);

2-4 x 400 (50 BF/50 FR) i=1'30"-2';

5-8 x 200 (50 BF/50 FR) i=40:-90";

12-16 x 100 (25 BF/25 FR) i=40"-60"

6-10 x 200 IM i=40"-90";

10-16 x 100 IM i=30"-60";

20 x 50 IM i=30";

800 + 2 x 400 + 4 x 200 + 8 x 100 + 16 x 50 i=30";

100+200+400+800+400+200+100 i=40"-90";

1 x 800 K;

2-3 x (400+300+200+100 i=30"-60") rest=2'-3';

1-2 x 800 IM (change stroke every 25, 50, or 100) i=2'-3;'

2-5 x 400 IM (change stroke every 25, 50 or 100) i=1'-2'.

Development of SPE

16-40 x 25 CRD, K, P i=30"-60";

8-16 x 50 CRD, P, K i=40"-90";

4-10 x 75-100 i=1'-3';

3-5 x 200 i=2'-5';

6-8 x (4 x 25 i=5"-15") rest=3'-5';

4-8 x (4-6 x 50 i=7"-15") rest=4'-5';

4-8 x (50+50 i=5"-10") rest=3'-5';

2-3 x (4 x 100 i=15"-20") rest=3'-5';

2-4 x 400 i=3'-5';

1-2 x (8 x 100 i=10"-15") rest=4'-5';

8-16 x 50 BF i=40"-90";

4-8 x 100 BF i=1'-3';

2-5 x 200 BF i=2'-3';

1 x 400 BF;

2-3 x (4-6 x 50 BF i=10"-15") rest=3'-4';

1-2 x (200 + 2 x 100 + 4 x 50 BF i=1');

3-8 x 200 IM i=2'-3';

5-8 x (4 x 25 IM i=5"-10") rest=3'-4';

8-15 x 100 IM i=1'30"-3';

4-6 x (4 x 50 IM i=5"-10") rest=3'-5';

5-8 x (4 x 25 IM i=5"-10") rest=3'-4';

3-6 x (8 x 25 K i=10"-15") rest=3'-4';

8-20 x 50 K i=40"-60";

6-12 x 100 K i=1'-2';

4-6 x 200 K i=1'30"-3';

1 x 400 K;

K (400+200+100+100+50+50 i=1'30"-2');

2-4 x (4 x 50 K i=15"-20") rest=3'-4';

400 + 200 + 200 + 100 + 100 + 50 + 50 i=3'-1';

2 x 400 + 4 x 200 + 8 x 100 + 16 x 50 i=2'-1'30";

400 + 2 x 200 + 4 x 100 + 8 x 50 i=3'-3'-3'-2'-2'-1';

50 + 50 + 100 + 150 + 200 + 150 + 100 + 50 + 50 i=1'-3';

2-4 x (200 + 2 x 100 + 4 x 50 or 4 x 50+ 2 x 100 + 200 i=1'-2') rest=3'-5';

2-4 x (4 x 25 + 2 x 50 + 100 BF i=10"-15") rest=2'-3';

1-3 x 400 IM (change stroke every 50 or 100) i=3'-5'.

Development of SPDE

10-20 x 25 CRD, K i=40"-90"

20-30 x 15-20 CRD, K i=30"-60";

4-10 x 30-40 i=1'30"-3';

Tethered swimming using stretch-cords: 10-20 x 15"-20" i=40"-90";

10-20 x 10-15 strokes or cycles i=1'.

AGE 14 YEARS

Development of BE-1

40-80 x 25 i=5"-15" (TR-2);

30-60 x 50 i=5"-20" (TR-1, 2);

15-30 x 100 i=10"-30";

10-20 x 150-200 i=10"-30" (TR-1, 2);

8-12 x 300-400 i=15"-40" (TR-1, 2);

4-8 x 500-600 i=20"-40" (TR-1, 2);

3-5 x 800-1000 i=30"-90" (TR-1,2);

1-3 x 1500-2000 i=1'-3' (TR-1, 2);

1 x 3000-5000 (TR-1)

1 x 800-1500 K

20-30 x 50 K i=10"-15";

10-20 x 100 K i=15"-20";

6-10 x 150-200 K i=15"-30";

2-3 x 300-400 K i=30"-40";

10-20 x 200 IM i=15"-30";

10-30 x 100 IM i=10"-20";

3-5 x 800 IM (change stroke every 50, 100 m) i=20"-60";

4-8 x 400 IM (change stroke every 50, 100 m) i=15"-30";

Development of BE-2

30-60 x 25 i=15"-20";

20-40 x 50 i=20"-30";

15-30 x 100 i=20"-40";

10-20 x 150-200 i=30"-60";

5-10 x 300-400 i=30"-90";

2-4 x 800-1000 i=1'30"-3';

1 x 1500-3000

3-5 x (6-8 x 100 i=10"-15") rest=1'30"-2';

20-30 x 50 K i=20"-30";

10-16 x 100 K i=20"-40";

4-8 x 150-200 K i=30"-40";

3-4 x 300-400 K i=1'-2';

20-30 x 50 BF i=15"-30";

15 x 20 x 100 BF i=20"-40";

8-12 x 150 BF i=20"-40";

6-8 x 200 BF i=30"-60";

3-5 x 400 (50 BF/50 FR) i=40"-90";

8-15 x 200 (50 BF/50 FR) i=30"-60";

10-15 x 200 IM i=20"-40";

15 x 20 x 100 IM i=20"-30";

3-5 x (5 x 200 i=15"-20") rest=1'30"-2';

3-4 x (400+300+200+100 i=30"-40") rest=2'-3';

800 + 2 x 400 + 4 x 200 + 8 x 100 + 16 x 100 rest=1'-4';

2-3 x 800 IM (change stroke every 25, 50, 100) i=40"-90";

3-6 x 400 IM (change stroke every 50, 100) i=30"-60";

K (400 + 200 + 200 + 100 + 100 + 50 + 50) i=30"-40".

The exercises belonging to training category BE-2 also include exercises performed within speeds more appropriate to category BE-1 but with "hypoxic" breathing patterns (breathing every 3rd-9th stroke or cycle).

Girls 13-14 years and boys 14-15 years of age have to execute significant volumes of BE-1 and BE-2 training while using paddles and other resistance devices (e.g., belts, pails, pockets, small weights). This is intended to provide simultaneous development of general functional abilities and strength of the pulling muscles.

Development of SPE

16-30 x 25 CRD, K i=30"-45";

10-20 x 50 i=40"-90";

3-6 x (4-8 x 50 i=10"-30") rest=3'-4';

6-12 x 75-100 i=2'4';

3-8 x 100 i=4'-5';

3-6 x 150-200 i=3'-5';

1-3 x 400 i=3'-5';

2-4 x (4 x 100 i=10"-20") rest=4'-7';

6-10 x (50+50 i=5"-7") rest=4'-6';

4-6 x (100 + 50 i=5"-10") rest=4'-6';

400 + 2 x 200 + 4 x 100 + 8 x 50 i=3'-2';

3-5 x (4x50 K i=10"-15") rest=3'-4';

8-16 x 50 K i=40"-90";

5-8 x 100 K i=40"-120";

3-5 x 200 K i=1'30"-3';

1-2 x 400 K i=3'-4';

8-20 x 50 BF i=40"-90";

5-10 x 100 BF i=1'-3';

3-6 x 150-200 BF i=1'-3';

1-2 x 400 BF i=4'-5';

2-4 x (4-6 x 50 BF i=5"-10") rest=4'-5';

BF (50 + 100 + 150 + 200 + 150 + 100 + 50 i=1'-2'-2'-3'-2'-2');

1-3 x (200 + 2 x 100 + 4 x 50 BF i=1'-2') rest=3'-5';

BF (400 + 200 + 200 + 100 + 100 + 50 + 50 i=3'-3'-3'-2'-2'-1');

K (400+200+200+100+100+50+50 i=2'-2'-2'-1'-1'-1');

400 + 200 + 200 + 100 + 100 + 50 + 50 i=3'-2';

2-4 x (200 + 2 x 100 + 4 x 50 i=1'-1'30") rest=3'-6';

50 + 50 + 100 + 200 + 400 + 200 + 100 + 50 + 50 i=1'-1'-2'-3'-3'-3'-2'-1'.

Development of SPDE

8-20 x 25 i=45"-2';

20-40 x 15-20 i=30"-2';

8-15 start efforts x 15-20 i=1'-2';

5-10 x 30-40 i=1'30"-2';

8-10 x 25 K i=40"-60";

20-30 x 15-20 K i=40"-60";

Tethered swimming with the usage of stretch-cords:

16-30 x 15"-20" CRD, K, P i=30"-60";

16-20 x 15-20 strokes or cycles i=40"-60"

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