A Physiological Perspective to Understanding Athlete Development: What Swim Coaches Need to Know

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It is important for coaches to have an understanding of the biological/physiological development of the young athlete as this knowledge can and should be implemented to maximize the child's potential. There are three primary physiological performance components that undergo quantitative changes (increased size or capacity) and qualitative changes (increased efficiency) with growth and development. The components include aerobic capacity, anaerobic capacity, and muscular strength, power and endurance.

Aerobic Capacity

- $V0^2$max, the ability to take in, transport, and utilize oxygen, is the common parameter used to measure aerobic capacity.
- $V0^2$max shows significant growth from 11-13 years for females and 12-14 for males. This time frame, when significant growth can occur (sensitive period), should be maximized in the training program to develop the athlete's long term potential. The athlete is able to rapidly increase workload during this sensitive period.
- Pre-pubescent athletes show significant improvements in long duration, low intensity events and are able to enhance the utilization of their aerobic capacity.

Recommendation: Coaches should optimize aerobic training during this "sensitive period" (11-13 years for females/12-14 years for males) to maximize athlete's aerobic development. It is suggested that pre-pubescent athletes (ages 9-12/14) focus on longer distances (i.e., longer repeats and longer competitive events) for reasons related to both skill development and aerobic capacity development.

Anaerobic Capacity

- Anaerobic training involves high intensity, brief activities (repeats on long rest or 25yd. sprints or less).
- It has been found that high volume pre-pubescent anaerobic work results in insignificant long-term anaerobic improvement for young athletes (10-13 years). It may result in short-term time drops.
- However, higher aerobic work during this time results in increased performance across all distances not just longer distances.
- Increased anaerobic load early leads to potential maladaptation in young athletes…it is said to "tax their tank" and their ability to adapt.

- A gradual increase in the proportion of anaerobic work beginning at ages 12-14 for girls and 13-15 for boys maximizes development and enhances performance, BUT only if preceded by ample aerobic work.

Recommendation: Coaches need to first develop the athlete's aerobic capacity and then gradually increase anaerobic load for maximum development of anaerobic capacity.

Muscular strength, power and endurance

- A frequently asked question is whether young athletes should be strength training. It is suggested that you can see muscular gains and adaptations but only if strength training is done under the right scenario -- with close supervision to ensure proper technique.
- Prior to puberty, the gains come from neuromuscular changes not changes in muscle size. With increases in steroid hormones (puberty), we see gains due to changes in muscle size (predominantly in males).
- As muscle size increases, so does strength. But, typically there is a year lag time between size/mass increases and maximum effects of strength gains in young athletes.
- Additionally, the translation of land-based strength, power, and endurance to pool performance can vary from half a year up to two years.
- The age of 14-15 is when peak gains occur; quantitative muscular changes can occur with proper training - "window of time where they are plastic". However, it is not until half a year up to two years later that this will be translated into an increase in strength.

Recommendations: First, keep in mind that young athletes are not miniature adults. Because of hormonal and biological differences between children and adults, children will not increase muscle size through strength training. However, neuromuscular adaptations can occur. It is only after puberty that muscle growth occurs. Keep in mind that the ability to translate muscular work to swimming velocity is the key, as our concern is helping children swim faster. Therefore, we must ensure that strength training is implemented or modified to meet this objective.