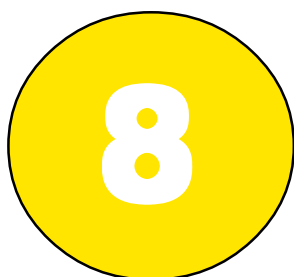




**SPORT
MEDICINE MANUAL**

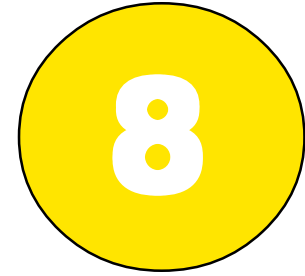


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CHILDREN IN COMPETITIVE SPORTS



A. Psychological and Sociological Well-being

The psychological well-being of children in sports programs can best be achieved by providing an environment which allows them to achieve a sense of competence, to feel that they have some control over their own actions and to achieve reward from the activity itself. Success in children's sport is measured in personal growth and development and not by winning and losing.

All leaders and persons involved with children's sports must display exemplary moral behaviour. Adults will strongly determine the values children learn from sport. Used positively, sport can enhance the well-being, enjoyment and normal growth of children. Used negatively, sport could contribute to physical and psychological abuse.

Through sport, children can develop positive life skills such as self-esteem, motivation, competitiveness, responsibility, discipline, work ethic, and moral and social development.

B. Physical and Motor Development

Adults who conduct sports programs for children must recognize that the physical working capacities of children will change. These changes are related more to levels of growth and maturity than to age.

Absolute maximal aerobic power ($\dot{V}O_2 \text{ max}$) increases in boys beyond post-puberty. In girls, increases in $\dot{V}O_2 \text{ max}$ are much less marked after puberty. Pre-pubertal children cannot generate energy for high intensity exercise at the same rate as adults.

Young (pre-pubertal) children show a limited capacity to improve endurance and strength. Coaches should not anticipate the same gains in aerobic capacity and muscular endurance that older children achieve. Children can perform endurance exercises which are scaled down to match their maturational state.



Pre-pubertal children will benefit most from learning a variety of fundamental motor skills, such as running, jumping, throwing and catching rather than restricting their activities to the skills of a specific sport.

C. Safety and Medical Concerns

- Chronological age should not be used as the sole criterion of partitioning children into homogeneous groups. Criteria which include height, weight, experience and skill level are much better predictors of success in sports
- Sports injuries, including serious head injuries, can be prevented or markedly reduced by a combination of effective equipment design, rule alterations, and education of the coach, parent and player concerning the function and purpose of protective equipment. All sports equipment, especially protective equipment, must be designed, constructed and sized in accordance with the size and growth characteristics of children.
- Potential for osteo-arthritic changes to joint surfaces exists in sports with high repetition loading such as running, rowing or gymnastics. Equipment and practice sessions designed to lessen impact forces can reduce potential for injury.
- Repeated loading at points of muscle insertions (attachments) or at joint surfaces can cause inflammation and alterations to these surfaces. Reducing the magnitude of loads will usually diminish associated injury.
- Fluid intake prior to and during practice or competition should be mandatory, regardless of environment temperature. Small amounts of water (100-150 ml) should be given every 15-20 minutes, even if the child is not thirsty. Deliberate fluid loss should be discouraged.
- Many children with chronic health problems can be encouraged to take part in sports training, sometimes making appropriate adjustments to their medical regimen. In most situations, sports training is beneficial to the overall growth and development of the child.
- Children taking part in intense sport activities do not require special diets or dietary supplements; the well-balanced diet is sufficient for most child athletes.
- Selecting children for specific sports at young ages is a questionable procedure. Children can be given advice about potential success in specific sports based on body-build characteristics, but there is little relationship between body size and/or shape and success in sports during childhood.
- Involvement in contact sports for preadolescent children is a controversial issue. With appropriate matching of participants for size and maturity level, evidence indicates that even the 10-14-year-old child is relatively safe, and severe injury is uncommon.



D. Physical Working Capacity in Children

Physical working capacity of children changes markedly with growth. A description of the capacity normally includes the responses to sub-maximal exercise, the measurement of maximal aerobic capacity and assessment of anaerobic capacity. The following are generally accepted facts on the physical working capacity of children.

Sub-Maximal Exercise

The energy costs ($\dot{V}O_2$) of walking and running is higher in children than in adults. For a constant sub-maximal work load, heart rate and breathing frequency are highest in young children, but decrease progressively with age. However, when the amount of work performed is proportional to body weight, the heart rate tends to be quite similar for all ages. The combination of age, height, body weight and heart size account for approximately 75% of the variation seen in sub-maximal working capacity during growth. Research dealing with cardiovascular and pulmonary factors, blood serum enzymes and other proteins have indicated that children could tolerate prolonged sub-maximal work and that the biological stress appears to be only moderate.

Maximal Aerobic Power

Maximal aerobic power, or $\dot{V}O_2$ max, increases beyond post-puberty in boys. In girls, however, the pattern is slightly different. Absolute $\dot{V}O_2$ max increases until puberty, after which it tends to remain constant until young adulthood. Furthermore, at all ages during growth, the average female value of $\dot{V}O_2$ max is lower than the average male value. For instance, before 10 to 12 years of age, the average female value of $\dot{V}O_2$ max reaches about 85%-90% of boys' mean $\dot{V}O_2$ max. Thereafter, ie. from this time until maturity, female values progressively decrease relative to mean male values, such that the average female $\dot{V}O_2$ max is estimated to be about 70% of that for the male after puberty.

Maximal oxygen uptake changes considerably less during growth when it is expressed per kg of body weight. Dimensional studies suggest that maximal aerobic capacity does not increase linearly with body weight in untrained boys, but it does in trained boys. Thus, in normally growing children with no particular training program, body mass increases at a slightly faster rate than $\dot{V}O_2$ max. On the other hand, it is well accepted that girls exhibit a decrease in $\dot{V}O_2$ max per kg of body weight with age. Thus, before 10 to 12 years of age, this capacity in females reaches about 90-95% of that of boys. Mean $\dot{V}O_2$ max per kg body weight of girls, relative to male values, decreases around puberty such that, by early adulthood, it is only about 80% of the mean male value.

It appears that if children are trained with appropriate frequency, intensity and duration of exercise, they will increase their maximal oxygen consumption values. The maximal values seen in elite pre-pubertal athletes is about 60-65 ml/kg/min while mature elite athletes have values of 70-80 ml/kg/min. The pre-pubertal values are about 20-30% higher than for sedentary children while the adult values are about 70% higher than for sedentary adults.

Anaerobic Capacities and Powers

Little is known concerning growth-associated changes in the capacity of the child to perform high intensity, short duration exercise. Recent data suggest that even when normalized for body weight, the ability of children to sustain supra-maximal exercise for 30 seconds is markedly lower than in young adults. During maximal work, children have a lower blood lactate concentration than adults. The same trend has been reported for muscle lactate, where concentrations during maximal work reach about 10 mmol/kg wet weight in pubertal children, compared to about 18 mmol/kg in adults. Furthermore, the maximal level of body fluid acidosis that can be reached in strenuous exercise is



lower in children than in adolescents or young adults. Thus, the capacity to generate energy for high intensity exercise through the anaerobic lactic acid system is lower in children than in adults.

E. Health and Sports Participation

Injuries to the Growth Plate or Joints

Damage can occur at the epiphysis as a result of repeated loading, causing micro-trauma. Two of the more common cases are Osgood-Schlatter's disease and Sever's disease at the knee and ankle, respectively. In these cases, the muscle insertion (attachment) begins to pull off fragments of the young bone. If the force is great enough, then major damage may ensue; however, actual occurrences of complete detachment are rare (see Unit 4, section A - Musculoskeletal).

Osteoarthritis may occur in those who traditionally undergo repetitive, high-force loading of the articular surfaces at the ankle, knee, hip, and spine during their respective training programs. However, it is believed that if the force on the articular surface of the joints is reduced while the number of repetitions is maintained, there is less disease. Thus, the challenge is to find this critical loading value and develop methods to reduce the severity of the load.

Environmental Stress

Strenuous physical exertion, especially when performed for more than a few minutes, induces increased production of metabolic heat and strains the thermoregulatory system. Such strain is further augmented if exercise is performed under environmental heat stress.

Because of their geometric and functional characteristics, children are at a disadvantage compared with adults when exposed to combined exercise and heat stresses. Such characteristics include:

- a high surface area/mass ratio which increases heat exchange per unit mass between the body and the environment, especially in climatic extremes
- greater metabolic heat production per unit mass during walking or running
- lower cardiac output per metabolic level during exercise which may limit conduction of heat from body core to periphery
- lower sweating rate in absolute terms and per unit surface area which may limit evaporative heat loss, which is the main avenue for heat dissipation during exercise

Although children acclimatize to exercise in the heat, the rate of acclimatization is slower than in adults. Children may also undergo voluntary hypohydration during prolonged activities in warm climates. It is likely therefore that, on transition to warm environments, exercising children may be more vulnerable to heat-related illness. In contrast, the changes in their perception of heat stress during the acclimatization phase are faster than in adults. (see Unit 9, Environmental Factors).

Medical Issues

Only a very small proportion of children have medical disabilities which would preclude all sports participation.



Diabetes should not prevent participation in any sport. It might be necessary to adjust diet, insulin dosage and site of insulin injection for optimal control and for prevention of hypoglycemia. (See Unit 13, section H - The Diabetic Athlete for more information). The American College of Sports Medicine and the American Diabetes Association at <http://www.msse.org> have further excellent materials.

Asthma is the most common chronic illness in childhood. In 5 of 6 asthmatics, the disease is mild and no sport limitation is necessary. Exercise-induced asthma is most severe after 3-5 minutes of intensive running. Participation may need to be adjusted for the severe asthmatic whose airway resistance cannot be controlled by medication. In asthmatic children, exercise-induced asthma is never as severe as the bronchospasm that occurs spontaneously in those children. (see Unit 10, section C ii for guidelines as to the use of anti-asthma medications).

Epilepsy might preclude participation in contact sports, however, this is controversial. Participation in other non-contact sports is usually possible. In some cases, participation in bicycle, motorcycle, equestrian and similar sports might not be advisable.

Congenital and rheumatic heart disease should not preclude sports participation in most cases of mild heart defects. However, the variable nature of the disease makes individual assessment necessary. Modified sports programs may be necessary for those with more significant defects. Heart murmurs occur in 80% of children and usually do not indicate an abnormality that would prevent full participation in sports.

Mild blood pressure elevation (up to 160/95 mmHg) should not preclude full sports participation. Aerobic exercise should be encouraged for those children with mild hypertension as an aid to weight control. Activity of low intensity and long duration may also result in slight reductions in blood pressure.





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For further information, refer to the following web site:

<http://www.naysi.com/>