
FIS Medical Committee Educational Series

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Children in competitive sports

Clinical implications

Introduction

Concern has been raised regarding the linear growth and pubertal development in children participating in gymnastics and ballet (1,2). Accordingly, it has been suggested that female gymnasts should decrease their training during puberty (3). In contrast, female swimmers, track athletes, rowers and volleyball players seem to grow and develop normally (2,4,5). Less is known about boys participating in competitive sports; however, the available data suggest that growth and puberty are little (6) or not affected by training (7,8).

The explanation for the restricted growth and delayed puberty in some sports and not in others is unclear. A possible adverse effect of intensive training on growth and puberty has been suggested (2,3), since catch-up growth has been observed and the normal menstrual pattern restored when training was markedly reduced. On the other hand, two studies have shown that differences in stature between children in different sports existed before the onset of training, indicating that constitutional factors may play a role in the selection of competitive athletes (4,9).

It is a common belief that gymnasts have disproportional body segments with relatively shorter legs, suggesting that repetitive compression of the epiphyses might inhibit growth of the long bones in gymnasts. However, most studies on body proportions have not found any differences between children from various sports (7,10).

Athletes in aesthetic sports such as gymnastics, figure skating and ballet dancers have been found to be leaner than athletes in other sports (1,11,12,13,14). A light body weight obviously enables these athletes and dancers to perform more acrobatic rotations and jumps than their heavier counterparts. A study of the body mass index (BMI) in children in competitive sports showed that BMI was reduced in female gymnasts long before the onset of training, indicating a selection of lean children into gymnastics (9). However, it has been suggested that gymnasts and ballet dancers have an exaggerated focus on nutrition, causing a negative energy balance in order to optimize their body composition (15)

Hormones known to be involved in normal growth and puberty may mediate the possible adverse effects of intensive training. Decreased levels of Insulin-like Growth Factor I (IGF-I) have been shown after short periods of exercise in adolescence (16,17). Low levels of estrogen excretion have been found in adolescent rowers with irregular menstrual patterns (18). This finding is somewhat in accordance with the lower levels of plasma estradiol found in some highly trained women athletes (19). However, it has not been established whether long-term intensive training in pubertal children is associated with decreased levels of hormonal factors.

Bone mineralization is dependent on sex hormones and female athletes with delayed age at menarche have been thought to be at risk of osteoporosis later in adult life (20). In contrast, the positive effect of mechanical stress on bones during childhood as a determinant of adult peak bone mass has received increasing attention during the past decade (21,22). This hypothesis has been confirmed in a study of pubertal female gymnasts who increased their whole body mineral content significantly after one year of training (23).

However, a negative energy intake has been related to decreased levels of hormonal factors, a delay in age at menarche and irregularities of the menstrual cycle (24,25) and thereby may compromise normal bone mineral accretion (18,26).

Clinical implications

Only very few competitive adolescent athletes attain the amount of training hours needed for success at major international competitions. However, the suggested impaired growth and pubertal development in some female athletes and ballet dancers emphasizes the need for guidelines concerning training intensities. This is especially important for athletes in aesthetic sports where regular training is started before onset of puberty and a low body weight is an advantage.

Considering that only little or no adverse effects of training on growth and pubertal development have been observed in children in sports corrected for constitutional factors, a suggested limit of 15 hours of training per week (27) seems reasonable beyond which prepubertal and pubertal athletes at risk should be examined regularly (every six to 12 months). The examination should include anthropometrical measurements, assessment of pubertal status, recording of injuries, statements of nutritional habits and information on parental heights and their pubertal development including the mother's age at menarche. If a decrease in linear growth is observed in combination with a late pubertal development, bone age, hormonal growth factors and sex hormones in the blood should be determined. These further investigations will help to determine whether the affected growth is due to constitutional factors, high training intensities, or in very rare cases disease. If constitutional delay and disease can be excluded, training intensities should be reduced considerably as a decrease in training intensity has been found to improve the tempo of linear growth and pubertal development (2). In order to estimate whether final height is compromised and pubertal development delayed, it is advised to follow the athletes until termination of puberty or at least until peak height velocity and, in girls, age at menarche is reached.

Perhaps training in tall-stature sports such as swimming and team handball should be designed according to the pubertal development of the single athlete as the timing and tempo of puberty varies significantly among adolescents. Thus, a balanced energy input and expenditure in aesthetic sports such as gymnastics may be more important for normal growth than a reduction of training intensity.

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