Muscle fatigue during high-intensity intermittent exercise in children

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Over the past fifteen years, physiologists have taken a great interest in studying muscle fatigue, particularly during high-intense dynamic intermittent exercise. In this condition, muscle fatigue could be defined as an inability to maintain short-term power output. During this type of exercise, young children are able to resist better to fatigue as compared to adults (Ratel et al., 2002a, 2004a). For instance, after ten 10-s cycling sprints separated by 30-s recovery intervals, 10-y-old boys are able to maintain their short-term leg power, whereas the cycling peak power of 20-y-old men and 15-y-old adolescents decreases by 28.5% and 18.5%, respectively (Ratel et al., 2002a). The same finding was observed following running sprints. After ten 10-s treadmill sprints separated by 15-s recovery intervals, the running peak power is maintained more successfully in 11.7-y-old boys than in 22.1-y-old men (Ratel et al., 2004a). In boys, the running peak power produced from the first to the tenth sprint decreases by 17.7%, whereas in men, the peak power output decreases by 43.3% (Ratel et al., 2004a). This better resistance to fatigue in children may be explained by their muscle characteristics, which are quantitatively and qualitatively different to those of adults (Ratel et al., 2003). When children perform the same relative work rate as adults such as in sprints, they generate lower absolute power values. In other words, given that muscle mass explains a large variance in power output during growth, the greater fatigue resistance in children might be related to their lower muscle mass involved during exercise. Some researchers also showed that children are equipped better for oxidative than glycolytic pathways. This metabolic profile would allow a lesser production and a better clearance of muscle by-products (H⁺, lactate, H₂PO₄⁻) harmful to contraction, and a faster resynthesis of initial creatine phosphate stores necessary to the reconstitution of short-term muscle power following high-intensity exercise. The better clearance of muscle by-products in children would be facilitated by their faster regulation of blood acid-base balance by ventilation during high-intensity intermittent exercise (Ratel et al., 2002b). In other words, the faster removal of blood H⁺ ions by ventilation in children would increase the pressure gradient for H⁺ ions between intra- and extra-cellular spaces and accelerate the diffusion of H⁺ ions across the sarcolemma and capillary wall. Furthermore, some reports indicated that the lesser ability of children to activate their type II motor units (considered as the most fatigable motor units) would also explain their greater resistance to fatigue during sustained intense contractions. During repeated bouts of sprints, it is also important to note that perceived exertion rate is lower in children as compared to adults (Ratel et al., in press). This could be related to the lower absolute work done and the lower accumulation of muscle by-products observed in children. The mode of exercise has also an effect on muscle fatigue during repeated sprints in children (Ratel et al., 2004a). Children experience greater fatigue and perceived exertion rates during running compared to cycling. This finding may be attributed to an additional muscle recruitment and increased appearance of muscle by-products during repeated running sprints. Given that children have a better ability than adults at repeating short-term sprints when recovery intervals are short and that training based on high-intensity intermittent exercises improves the aerobic and anaerobic fitness of children, this type of exercise should be considered in the athletic programmes to improve their physical fitness (Ratel et al., 2004b).

References