Effect of gender and training on cardiovascular response to exercise in children

Obert Philippe
JE2426 Laboratory of Cardiovascular Physiology, University of Avignon, France.

Effect of maturation and gender on cardiovascular response to acute exercise: According to the Fick principle, oxygen uptake (VO2) increases during an incremental exercise test in adults on account of a concomitant increase in arterio-venous oxygen difference (AVO2) and cardiac output (Qc). Up approximately to 50-60% VO2max both stroke volume (SV) and heart rate (Hr) contribute to Qc improvement whereas for higher exercise intensity SV plateau and only Hr is responsible for Qc increase. It has been clearly established that children respond qualitatively using similar mechanisms (3,8). In addition, when young adults and children of similar aerobic potential (VO2max ml/min/kg) are compared, no differences exist between groups regarding Qc, SV and Hr provided that overall body dimensions are taken into account (3). Whatever maturational status, SV represents a crucial component of Qc and subsequently VO2max. Nottin et al. (3) reported no differences between young men and boys regarding left ventricular (LV) filling as well as emptying indexes (i.e. LV diastolic and systolic diameters, ejection fraction) at the same relative submaximal and maximal intensity. A maturational effect exist however on peripheral factors. Indeed, higher peripheral vascular resistances (RVP) and lower AVO2 are classically observed in children whatever exercise intensity (3). The contribution to this apparent maturational effect of oxygen carrying capacity, muscle mass engaged in exercise as well as vascular factors controlling peripheral blood flow will need to be clarified in further investigations. Several studies have shown that the cardiovascular response to acute exercise in children is not affected by gender (5). Even in prepubertal children, girls exhibit lower VO2max than boys, even if factors such as habitual physical activity or sport participation are considered (2,5). However, Vinet et al. (9) clearly demonstrated the sole limiting factor that distinguished boys from girls was a lower SVmax in the latter. However, this gender difference totally disappeared when normalized for lean body mass. Consequently, the gender difference in heart size and cardiac function during exercise should be interpreted as only one aspect of the lower lean body mass in girls and not as reflective of a more basic functional gender difference.

Effect of maturation and gender on cardiovascular response to chronic exercise: In healthy children, aerobic training increases VO2max but magnitude of improvement (5-15%) appears to be limited when compared to young adults (15-30%), even if training stimuli or initial physical fitness are taken into account (2,7). Mechanisms (i.e. central and/or peripheral adaptations) by which VO2max increases in children after training are not yet fully elucidated. Cross-sectional as well as longitudinal studies have reported higher VO2max in endurance trained children because of higher SVmax only (8). SV patterns from rest to maximal exercise does not appears however to be altered by training (5,8). Obert et al. (5) recently showed that the same adaptive processes are found irrespective of gender. Very few studies investigated in a comprehensive way factors potentially responsible for training-induced improvement in SVmax. It is well-established that SV depends on a complex interplay between cardiac dimensions, loading conditions and intrinsic myocardial contractile and relaxation properties. Several studies reported LV hypertrophy in endurance trained children. Opposite to adults, cardiac remodelling after training in children is characterised by LV cavity enlargement without wall thickness changes (5). The significance of such a specific remodelling to SVmax improvement is unknown. However, it has been recently demonstrated that LV internal dimensions contribute modestly but significantly (8%) to the explanation of VO2max variance in boys and girls (6). The implication of training-induced increase in LV preload conditions has also been presented (5). Indeed, several echo-Doppler indexes sensitive to preload (i.e. transmitral inflow characteristics) have been shown to be enhanced as a result of endurance training, although this is not universally accepted (5,8). Changes in cardiac afterload might also be involved as decrease in systemic vascular resistances (SVR) have been reported in children after an endurance training program (5). However, results from cross-sectional studies disagree as similar SVRmax were obtained between endurance trained and untrained children (1). Tissue Doppler imaging provides information on LV relaxation properties. A recent application of this new technique to endurance trained children demonstrated a favourable impact of training on LV relaxation properties, which could also contribute to SV enhancement during exercise (4). Improvement in VO2max after aerobic training are observed in both boys and girls, on account of increase in SVmax only. Similar mechanisms including increase in pre-load and decrease in after-load conditions as well as cardiac enlargement contribute principally to SVmax improvement (5). Effect of gender on magnitude of VO2max increase depend on studies (2,5) and factors related to initial physical fitness and training program characteristics explain part of the heterogeneity of the literature.

References: