Children's Biological Readiness and Explosive Lifting

Resistance training has beneficial effects on children (defined as 1yr old to pre-puberty around 11-13yrs old), adolescents, adults, on through to older adults. Good program design should be appropriate for the child's biological maturity as opposed to adhering to a strictly chronological age since children experience different rates of biological, mental, emotional, cognitive, and psychological development (Kerr, 2013; Kubo, Teshima, Hirose, & Tsunoda, 2014). For children who display advanced abilities and capacities in those aforementioned areas of maturation, they may be allowed under close supervision to learn and try more advanced skills or challenges (Kerr, 2013).

Explosive lifting has a long-standing history especially in Europe and Russia, and is quickly gaining popularity as a training modality even amongst non-athletes (e.g. the general weight loss client, the recreational client, the everyday fitness demographic). Explosive lifting usually refers to competitive Olympic-style lifts such as the clean-and-jerk and snatch which require maximal force production in minimal time (explosive strength, an extremely high rate of force development, RFD), highly coordinated and trained neuromuscular system, and focus/concentration to recruit all the components in a split second (Dotan et al., 2012; Newton & Jenkins, 2013). Additionally, Olympic-style weight lifting (OWL) requires a lot of time and dedication to master properly and execute safely (Newton & Jenkins, 2013). With regards to age-appropriate explosive lifting or OWL training (especially referring to young children up through pre-pubescent youth), it may be prudent to consider the biological maturity and readiness of an individual (as opposed to chronological age-group).

Dotan et al. (2012) and Dotan et al. (2013) noted that children have proportionately (physical size taken into account) lower maximal force, contractile velocity, lower RFD (perhaps due to shorter muscles or fewer sarcomeres in series), lower rate of torque development (RTD), and muscular power in contrast to adolescents and adults. Children have up to 10% or more type-I muscle fibers and lower type-II muscle fiber composition as compared to adults, which may contribute to some child-adult differences in strength and energy requirements (Dotan et al., 2012). Dotan et al. (2012) and Waugh, Korff, Fath, and Blazevich (2013) also noted that children's motor unit activation was less when compared to adolescents and adults. Also in Dotan's et al. (2012) review, children showed longer electromechanical delay (EMD, a latency period before muscle showed any activity on the electromyography, EMG). The ability to activate and produce force quickly is important to athletic balance, stability, reaction, and the performance of complex skills such as explosive lifting (Waugh et al., 2013).

EMD is inversely related to tendon-stiffness or the property of Young's modulus (tensile modulus) which describes "stiffness" of an elastic material (Dotan et al., 2012). Less tendon-stiffness (as with children) means that the tendon exhibits more elastic properties (which can affect lower RFD as well) (Dotan et al., 2012; Kubo et al., 2014). The physical size (length and cross-sectional area, CSA) also contribute to a tendon's stiffness (Waugh, Korff, Fath, & Blazevich, 2014). The consideration of tendon development in young children is important because tendons help transfer force across the joints to the bones (Waugh et al., 2013; Waugh et al., 2014). Interestingly, the tendon's physical properties and tensile modulus develop/grow at different rates (Waugh et al., 2014). The stiffness of the tendon affects the rate and efficiency of force transfer (Waugh et al., 2013).

Waugh et al. (2013) compared tendon stiffness in pre-pubescent children and adult men and women with the goal of observing tendon stiffness (plantar flexion on Achilles tendon) and age, EMD, and RFD; and whether tendon stiffness could be correlated to rate of muscle activation. Waugh et al. (2013) found that EMD, RFD, and rate of EMG increase (REI) was significantly different between children of 5yrs old and adults. Rapid force production in children (influenced by RFD and EMD) is dependent on increased rate of muscle recruitment and the tendon's tensile properties (Waugh et al., 2013). Waugh et al. (2013) also noted that neural maturation may occur around 7 to 10 yrs old as evident in the greater muscle activation rates with older children as compared to younger children.

Kubo's et al. (2014) study observed properties of the Achilles via plantar flexion via the medial gastrocnemius in 22 elementary school children (ESC), 19 junior high children (JHC), and 23 young adults (ADT). Kubo et al. (2014) found that the tendon structures were more "extensible" (more elastic as opposed to stiff) in ESC as compared to JHS as compared to ADT. Maximal tendon strain was also greater in ESC as compared to ADT (Kubo et al., 2014).

There are many benefits to explosive lifting and OWL. However, the individual's biological maturity/readiness should be seriously considered in coaching and program design in order to avoid unnecessary injuries under such great exacting demands of the sport.

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