Trainability of Young Athletes: Short-Term Goals or Long-Term Mission?

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At the time of writing this editorial on the Trainability of Young Athletes, the Olympic Games at Rio de Janeiro are in full swing. The Rio games are of interest to those working with young athletes as it is the time that the first Olympians born since the millennium will be competing. In fact, the youngest competitor, swimmer Gaurika Singh from Nepal (at 13 years and 255 days), won her heat in the 100 m backstroke, even though her time was not fast enough to progress any further in the competition. For those who like their Olympic history, do you know the age of the youngest Olympian in the history of the Games? (Answer at the end of this editorial.) I specifically mention the turn of the Millennium because at the announcement in 2005 of the award of the Olympic Games to London, with Lord Sebastian Coe’s vision of a Legacy for Youth, it became clear to many national governing bodies (NGB) in the UK, that youth sporting plans were either limited or nonexistent, a situation likely replicated in many other countries around the world. The turn of the 21st century also brought about renewed interest in youth athlete development models e.g., Bayli and Hamilton (1) and Cote et al. (2) among others. While there is still much research required to provide a scientific basis for the underpinning of these models, long-term athlete development (LTAD) remains an ideology rather than a precise scientific model (3). The natural conclusion of these observations and the first of my rallying calls to pediatric sports science researchers is that more empirical data are required on young athletes and potential athletes.

This special edition organized by Pediatric Exercise Science is just one of the ways in which we, as researchers, can promote the importance of this topic. Although no universally accepted definition of a youth athlete exists, I define it as ‘a child or adolescent who is still growing and maturing toward adulthood and who systematically trains (> once per week) and competes (> 1-year competition history) in at least one specific sport.’ As a researchers who has worked with many NGBs in the UK and professional clubs re: youth sports, there are a number of important issues that need to be researched so as to move this area forward. Firstly, there is the issue of the wholly disproportionate participation numbers of youngsters training and competing compared with the amount of scientific data that describes their physiological, psychological and sociological (mal)-adaptations. This type of work is especially crucial when it is now considered that youngsters engaged in sports training are becoming more highly specialized and professionalized at a younger and younger age. Is this a good way forward for the health of our young athletes?

The first two articles in this special edition focus on issues related to injury risk by McKay et al. (4) and physiological adaptations following resistance training by Legerlotz et al. (5) McKay and colleagues pose an interesting premise that adolescence is a time of neuromuscular, cognitive and hormonal change, representative of intrinsic factors, which predispose them to sports-related injury. Alongside this work, the narrative review of Legerlotz and colleagues rightly concludes that over the last decade mounting evidence has shown that resistance training, if conducted appropriately, is an effective training intervention for youth athletes. Researchers in this area are to be applauded for their efforts, as previously it was considered that resistance training should not be promoted for youngsters. The authors point out that the examination of such factors as muscle and tendon morphology has not typically been investigated, despite the advancements in ultrasound techniques. It is anticipated that as the costs of many new noninvasive instrumentation become more affordable, greater possibilities will be made available. Summatively, the authors make an important observation that based on evidence to date, training-induced adaptations appear to follow similar principles to adults but that the adaptive response is more subtle in children. This observation immediately has consequences for ensuring researchers are able to tease apart training adaptations (or maladaptation in the form of injuries) from growth and maturational changes.

The next four invited papers by Hammami et al. (6), Cripps et al. (7), Myburgh et al. (8) and Kraemer et al. (9), all focus on the issues of maturity, growth and functional abilities of young athletes. Hammami and colleagues investigated associations between balance, strength and
power across different estimated maturity status using peak height velocity (PHV). Interestingly, significant and positive correlations found in this group of 130 soccer players (age range 10–18 y) between balance, strength and power are not typically observed in nonathletes. The correlations tended to increase with increasing maturity but the associations between balance, strength and jumping performance is an interesting one, and could be seen as complementary to the more traditional training approaches based on speed and strength work. The study by Cripps et al. is an excellent example of how researchers can increase the impact of their research by involving coaches and their support teams in the research process with semielite adolescent footballers (n = 94, 15.7 ±0.3 y) and investigating how maturity affects skill and coaches’ perceptions of skill. It was found that earlier maturing athletes are also perceived by coaches to have superior technical abilities, despite no congruent technical skill advantage evident in technical skills testing. These observations point to the importance of coach education in understanding these outcome permutations and the “compensation phenomenon” a younger and less mature athlete must display higher technical skills (relative to their physical disadvantage) to remain in the selected squad. Myburgh and colleagues continue the investigation of early and late maturity but this time in elite junior tennis players (n = 88, 44 females, 8–16 y). They found advanced maturity brought about advantages in most measurements, but not all, for boys and girls. However, it was pointed out that sports like tennis require a well-rounded physical fitness capability, which will be developed over years and as such, the effects of differing maturity should be factored into the training prescription of players rather than just basing training on chronological age and a “one-size fits all.” In fact, this statement is equally true and could be applied to most youth sports. Finally, Kramer et al. (9), also focusing on national tennis players from the Netherlands, investigated longitudinally the fitness improvements in males and females (males = 113, females 83, age range 13–15 y) relative to maturity, age and performance. A unique feature of this study was the use of longitudinal modeling or multilevel modeling and the advantage of access to routinely collected data within an academy setting. This is the second issue that I call upon pediatric researchers to respond to, which is to collaborate with youth sports academies who are often sitting (not quite literally) on large data-sets, but who are unsure what to do with it.

The next three articles by Lynch et al. (10), Maciejewski et al. (11), and Crewther et al. (12), respectively all deal with matters related to performance and testing in three sports: sprinting, rowing and weightlifting. In reference to my comment about using large data bases, Lynch and colleagues have truly surpassed my wish by analyzing more than 35,000 athletes over a total of 1,627,652 races. Taking account of training exposure, history and baseline ability, it was concluded that baseline ability [defined as result in first high school race] explained between 40–51% [dependent on the event] of the variation in performance and was consistently higher for females than males. By accounting for baseline abilities, coaches and their sports science support teams can begin to experiment by how much faster an athlete might become through training and race experience. Whether these figures appear consistent across other sports remain to be observed. In relation to laboratory testing and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance, Maciejewski and colleagues explored the well-known relationship between power output and rowing performance. The mean power output in the modified Wingate test and the indoor 1500 m test correlated strongly r² = .83, while allometrically scaled data showed that total muscle mass accounted for 62% of the relationship between Wingate power and the 1500-m power out. In conclusion, the authors called for further work to verify these laboratory power scores to on-the-water performance and to examine these relationships longitudinally. These opportunities exemplify the laboratory- and field-based approaches that sports research can offer to coaches and their sports science support staff. The work of Crewther and colleagues needs to be acknowledged for tackling the difficult task of investigating the effects of hormones on sporting performance. Both females (n = 26, 16.5 ±0.9 y) and males (n = 26, 16.5 ±1.1 y) participated in this study to measure testosterone (T), cortisol, dehydroepiandrosterone-sulfate (DHEA-s) and sex-hormone binding globulin pre- and postcompetition. While the DHEA-s and T in girls moderately correlated with weightlifting performance, body mass appeared to be acting as a mediator for boys but a suppressor for girls. As the authors acknowledged, there are a considerable number of other factors that need to be considered when interpreting their results, not least of all body composition, plasma volume shifts and maturity. The final article focuses on a topic which is rarely investigated in young athletes and that is, sleep. Previous research has highlighted the consequences of poor sleep habits and general tiredness due to training as being associated with nonfunctional overreaching (13). So in this study by Suppiah and colleagues (14), 29 participants (age 14.7 ± 1.3 y) from shooting and track & field academies were tested to examine the effects of a week’s training and also differences in exercise intensity of training on sleep habits. Important findings were the lack of total sleep per night relative to recommendations and the accruing sleep debt over five weekday nights, which significantly impacted on psychomotor performance. As a topic that lacks empirical data and with the increased likelihood of young athletes traveling internationally to train and compete, this area is ripe for investigation.

In summary, this special edition has highlighted numerous important areas. Firstly, more empirical data are needed on young athletes per se. Secondly, aspects
related to growth, maturation and training need investigating especially in relation to the health and well-being of the athlete. Thirdly, sports academies are beginning to amass data that, with researchers’ collaboration, can prove useful to investigate these issues. Finally, areas such as hormonal responses or adaptations and sleep habits point to future research opportunities. The field of youth athlete development is wide open, as a case could be made equally for other aspects of youth training e.g., nutrition. So I sign off with a rallying call for greater engagement in youth sports research. Finally, the answer to the youngest Olympian is? Well, it is a Greek gymnast Dimitrios Loundras, who competed at the inaugural modern Games in 1896 and at 10-years old, won a bronze medal in Athens, thereby going into the record books also as the youngest medal winner. A case for support of the 10-year training rule? Perhaps not!

References