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Biobanding: A new paradigm for youth sport and training

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~~Participation in organized sport is a fact of life for the majority of children and adolescents of both sexes. It is estimated that approximately 36.25 million children and youth 5-18 years in the U.S. participate in organized sports (<https://www.statisticbrain.com/youth-sports-statistics/>).~~ Although objectives vary, the development of sport and related movement skills, fun/enjoyment, the concepts of fair play and sportsmanship, and social and life skills are a focus of most programs. Sport also provides an opportunity for physical activity on a regular basis, although activity varies considerably among sports and between practice/training and competition. The benefits of participation in sports are, however, not automatic. They depend in large part on adults and adult-driven environments associated with training and competition in many sports. A range of potentially harmful outcomes has been associated with participation in sport, including poor sportsmanship, perceptions of low competence, violence and aggression, burnout, risk of disordered eating, sex abuse, among others. Risk of injury is, of course, associated with participation in sport, both organized and informal.

Since pediatricians are the medical professional most likely to interact with youth patients and their parents, they are well positioned to provide advice on the potential benefits and risks associated with sports participation.

Maturity-associated variation in size, strength and power play a significant role in many popular sports among boys – soccer, American football, baseball, and ice hockey, among others. Success in these sports during the transition into adolescence (circa 11-14 years) tends to favor

early maturing boys ~~during the transition into adolescence (circa 11–14 years)~~. Corresponding trends among females ~~in many sports tend to favor~~indicate greater likelihood of success among later maturing girls in aesthetic sports, especially gymnastics, distance running, ballet and figure skating, while girls who mature on time or in advance of their peers are more likely to be represented among participants in sports which emphasize size, strength and power, e.g., swimming, tennis, basketball, and several track and field disciplines (Malina, 1994). In addition, early maturing girls are often more likely to drop out of sport (Sherar et al., 2010).

Concern for individual differences in biological maturation among boys was expressed over 100 years ago. Crampton (1908) proposed the use of “physiological age” based on pubic hair development as an index of readiness for the *work force*, while Rotch (1908) highlighted the dissociation of chronological age and “anatomical age” - based on hand-wrist radiographs - among youth, and noted the relevance of anatomical age for school, child labor and *athletics*. It has also been suggested that “...biological age-screening is a very wise and useful protective mechanism” (Krogman, 1959, p. 56)

The concept of matching youth athletes on the basis of growth and/or maturity characteristics has been applied in several sports to optimize equity and safety, or in deciding when a youngster can “play up”:- It has been central to youth wrestling and judo, while similar efforts have been applied to youth rugby and American football in which teams and/or specific positions are restricted to youth within specific age and body weight limits. The New York State Public High School Athletic Association also proposed a systematic procedure in the early 1980s for evaluating the biological and behavioral readiness of 7th and 8th grade boys to “play up”, i.e., participate in interscholastic sports (Malina and Beunen, 1996). Note, in many small communities, 8th grade boys are often called upon to play with the high school football team.

“Biobanding” is the most recent iteration of the maturity matching concept for sport during the pubertal years, about 9-14 years in girls and 10-16 years in boys, intervals during which maturity-associated variation in size, strength and power is significant, more so in boys than in girls. Youth participants within a specific chronological age range are grouped within a band or range of estimated maturity status for competition and also for training. This approach is most relevant during the pubertal years—about 9–14 years in girls and 10–16 years in boys, intervals during which maturity-associated variation in size, strength and power is significant, ~~more so in boys than in girls.~~ Note, biobanding does not preclude the use of psychological and/or technical development for grouping purposes.

Biobanding should be viewed as an adjunct to rather than a replacement for age group competitions which are well-established in many sports (Cumming et al., 2017). Grouping youth by age has many potential benefits in terms of experience, cognitive and social development, and perhaps specific movement skills not dependent upon strength and power.

As applied in the context of youth soccer, biobanding has used a non-invasive indicator of maturity status, specifically percentage of predicted adult stature at the time of observation (based on age, height and weight of the youngster and mid-parent height), in an effort to reduce maturity-related mismatches in size and athleticism. Several youth soccer competitions restricted to boys 11 to 14 years of age with predicted adult heights at the time of observation that fell between 85% and 90% of expected adult stature have been trialed by the English Premier League with promising results. By competing against and playing with physically matched, yet older and more experienced players, young early maturing boys were exposed to a greater level of challenge and could not rely solely on their physical dominance. To succeed, they had to utilize

their technical, tactical and psychological skills and had to adjust to a style of play that was more advanced and played at a faster speed. Younger early maturing boys also benefited from being mentored by and learning from older peers. In contrast, older late maturing boys described the experience of playing down as less challenging physically and technically, but did note the benefit of having more opportunities to use and demonstrate their technical, tactical, and physical competencies and to adopt positions of leadership. Both early and late developers considered bio-banded games to be less physical, and more technically and tactically oriented than age group games. These observations were recently verified in observations that the practice of biobanding in soccer was associated with twice as much passing and dribbling than observed in age group games (Thomas et al., 2017). Socially, both early and late developers described biobanded games as opportunities to play with and make new friends.

Implications of biobanding, appropriately applied, for talent identification and development are obvious. Grouping athletes within chronological age bands by maturity status (allowing for technical competence) may have benefits in terms of optimizing training. Improvements in speed, agility and movement skills in general during childhood are largely associated with adaptations of the neuromuscular system, whereas hormonal changes and accelerated growth especially in muscle mass during puberty may be complemented with appropriate strength training protocols. In addition, attention to maturity status in association with developmentally appropriate training may reduce the risk of injuries, especially those associated with rapid growth, for example, Sever's (apophysitis of the calcaneus) and Osgood-Schlatter's (apophysitis of the tibial tubercle) diseases.

How does this “new” look at youth sport affect the pediatrician? We are the usual primary care physician for youth/adolescents. Part of the charge is to protect their

health and also to provide anticipatory guidance is a tenant of our craft as needed. The pediatrician and those on the team caring for youth who participate in physical activity and sport can also provide the rationale to youth sport organizations, as well as the practical aspects of the process of biobanding (Sherar, et al; Cumming, et al). Through education, the pediatrician can also address any concern that athletes or parents might have with regards to the practice of playing with and competing younger or older peers. Tracking of developmentally-related injuries as noted above may reinforce the use this form of developmentally appropriate training and competition.

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