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BRIEF REVIEW

Long-Term Athletic Development: Part 1: A Pathway for All Youth

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Abstract

Lloyd, RS, Oliver, JL, Faigenbaum, AD, Howard, R, De Ste Croix, M, Williams, CA, Best, TM, Alvar, BA, Micheli, LJ, Thomas, DP, Hatfield, D, Cronin, JB, and Myer, GD. Long-term athletic development: Part 1: A pathway for all youth. J Strength Cond Res XX(X): 000–000, 2015—The concept of developing talent and athleticism in youth is the goal of many coaches and sports systems. Consequently, an increasing number of sporting organizations have adopted long-term athletic development models in an attempt to provide a structured approach to the training of youth. It is clear that maximizing sporting talent is an important goal of long-term athletic development models. However, ensuring that youth of all ages and abilities are provided with a strategic plan for the development of their health and physical fitness is also important to maximize physical activity participation rates, reduce the risk of sport- and activity-related injury, and to ensure long-term health and well-being. Critical reviews of independent models of long-term athletic development are already present within the literature; however, to the best of our knowledge, a comprehensive examination and review of the most prominent models does not exist. Additionally, considerations of modern day issues that may impact on the success of any long-term athletic development model are lacking, as are proposed solutions to address such issues. Therefore, within this 2-part commentary, Part 1 provides a critical review of existing models of practice for long-term athletic development and introduces a composite youth development model that includes the integration of psychosocial and physical development across maturation. Part 2 identifies limiting factors that may restrict the success of such models and offers potential solutions.

Key Words children, adolescents, health, fitness, performance, resistance training

Introduction

Although a number of existing development models are designed to optimize sporting talent towards a senior level, a pertinent question that practitioners must ask is should we only be interested in developing elite young athletes? The number of youth who can expect to successfully follow the pathway from grassroots youth sport to elite professional sport is relatively small. In comparison, there will be a greater number of youth who opt to play sport only at a recreational level, or as current data would suggest, do not participate in organized sports or fail to accumulate the daily physical activity guidelines recommended by leading health authorities (60). Consequently, it would seem intuitively naive to overlook the potential benefits of long-term athletic development as a pathway that could enhance the health, fitness, and performance of all children and adolescents.

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Owing to semantics, long-term athletic development could be interpreted as a training philosophy exclusively for young athletes. However, researchers would argue that for long-term health benefits, the hallmarks of modern day long-term athletic development models are not only appropriate but also essential for all youth (30). In fact, the use of the terms "athlete," "athletic," "sport," or "talent" within existing models is arguably inappropriate as it implies that such models are designed only for a small minority of children and adolescents who demonstrate exceptional "athleticism" or "talent" within a given sport or activity early in life. The development of sporting talent is very important, highly valued, and extremely rewarding for both athletes and practitioners alike; however, it is imperative from a public health perspective that a structured, progressive, and integrated approach to youth training is viewed as a developmental pathway for children and adolescents of all ages and abilities.

Operational Terms

For the purposes of this commentary, the terms youth and young athletes represent both children (generally up to the age of 11 years in girls and 13 years in boys) and adolescents (typically including girls aged 12–18 years and boys aged 14–18 years). The term athletic development refers to the physical development of youth that encompasses the training of health-, skill-, and performance-related components of fitness. The age-related integration of these components over time is designed to enhance performance, reduce injury risk, and enhance the confidence and competence of all youth. Practitioner denotes an individual responsible for the athletic development of youth and includes youth sport coaches, sports administrators, strength and conditioning coaches, physical education teachers, athletic trainers, physiotherapists, and other health care providers. Resistance training refers to a specialized method of conditioning, whereby an individual is working against a wide range of resistive loads to enhance health, fitness, and performance (29). Forms of resistance training include the use of body weight, weight machines, free weights (barbells and dumbbells), elastic bands, and medicine balls. Physical literacy signifies the ability of an individual to use cognitive processes such as anticipation, memory, and decision-making to help move with poise, economy, and confidence in a range of physically demanding environments (59). Fundamental movement skills represent locomotive (running, skipping, and hopping), manipulative (catching, throwing, grasping, and striking), and stabilization (balance, rotation, and antirotation and bracing) skills (32).

Physical Fitness in Youth: The Current State of Play

The interest in the health, fitness, and well-being of modern day youth seems to be at an all time high, with increasing concerns over the prevalence of physical inactivity, childhood obesity and its association with the development of noncommunicable disease (16,26,41,42,48,50,53,58,60). Additionally, increasing participation rates in organized youth sports (25,38) and greater numbers of youth memberships within health and fitness clubs (27,61) demonstrate that there is a growing interest in enhancing the health and fitness of children and adolescents (39). As a consequence of these combined interests, the concept of structuring long-term approaches for youth physical development has gained attention in recent times. In fact, leading agencies and governing bodies now promote that all youth should engage in daily physical activity from an early age (2,20,52,54,60). Published guidelines suggest that such activities should develop cardiorespiratory and metabolic fitness, muscle and bone strength, and movement coordination and control, while reducing the symptoms of psychosocial ill-health (60). More specific training prescription directives have appeared within the sports performance context, with many National Governing Bodies (NGBs) or professional sporting associations (34) now possessing long-term athletic development policies to increase the potential of sporting success at the elite senior level (40). Of note, many of these programs are predominantly sport-specific in nature. Such sport-specific programs typically provide guidelines for practitioners to focus on particular training methods at certain stages of development to enhance physical fitness and to reduce their relative risk of injury.

Enhancing physical fitness in youth is a complex and dynamic issue, due to the varying interactions of growth, maturation, and training (31). Additionally, to ensure the holistic development of youth, practitioners must be cognizant of psychosocial, educational, and lifestyle factors that may impact upon engagement, adherence, and overall enjoyment of the sporting and training experience (29). Irrespective of whether youth are involved in organized sport, there often remain varying levels of understanding and a general lack of coordinated planning among those practitioners who are ultimately responsible for the long-term welfare and well-being of youth. Consequently, despite global physical activity recommendations and the existence of models of talent identification and development, the numbers of youth displaying substandard levels of physical fitness, muscular strength, and motor skill competency is increasing globally (12,37,43,45,49,52,56). A contemporary corollary of reduced levels of physical fitness in modern day youth is an increase in the number of youth experiencing sports- and physical activity–related injuries (1,7,9), overtraining and nonfunctional overreaching (33), burnout (17), and eventual dropout from their chosen sport(s), which remains a concern for practitioners.

Existing Models of Talent and Athletic Development

When examining existing development models for youth, it is clear that the central tenet of a number of models is not necessarily athletic development per se but rather talent development for sport(s). Of note, very few models exist that

clearly define training prescription directives for youth of different maturational stages or with different levels of training history and technical competency. For the purposes of this review, prominent models from within the different domains of talent and athletic development will be discussed independently. Finally, a composite youth development model will be proposed to demonstrate how existing models could be combined to aid the holistic development of youth from both a talent and physical fitness perspective.

Talent Development Models

Perhaps, the most simplistic concept of talent development is the Participant Model of Sport Development, a pyramidal continuum for developing talent. Several versions of the pyramid model exist (3,51), but all are characterized by a base level of large participation rates in foundation activities, with decreasing participation as performance and competition levels increase. The theory of the pyramid approach to sport development dictates that physical education should serve as the foundation where basic fundamental movement skills are initially taught. These skills are then further developed within increasingly demanding and more competitive environments as the child transitions from school-based activities to elite-level sport competition. Despite this model illustrating a clear pathway for talent development, its simplicity is also a limitation. The model does not account for individual differences in growth and maturation, rate of learning, and importantly fails to acknowledge those individuals who drop out at a certain level of performance or those who begin participating in sports and organized training during adolescence. Despite the emphasis on learning fundamental movement skills early in life during physical education, the model assumes that all participants will follow the same sequential pathway from initial participation to elite performance.

The Differentiated Model of Giftedness and Talent (DMGT) (23) (Figure 1) outlines a clear distinction between naturally untrained abilities (gifts) and systematically developed abilities (talent). Gagné (23) proposed that for an individual to translate a "gift" into a "talent," a child or adolescent must engage in systematic learning and practicing of skills. Gagné (23) suggested that such a learning or practice should seek to develop intellectual, creative, socioaffective, and sensorimotor aptitudes to maximize talent. Furthermore, Gagné (23) recommended that the intensity of practice should increase in relation to the level of talent sought by the individual. The author (2 3) originally devised the model within education where gifted and talent pro- grams (e.g., in mathematics and science) have been more extensively studied. However, the model's philosophy of developing the individual across a multitude of aptitudes could be applied to the long-term athletic development of all youth to enhance a child's ability to perform a variety of skills across a range of different sports or activities.

Another talent development model that has evolved from the education and sporting literature is the Model of Talent Development in Physical Education (4). The model is based on research within the domain of talent development in physical education, and the researchers concluded that the process of development is multidimensional in nature, with the goal of enhancing psychomotor, interpersonal, intraper- sonal, cognitive, and creative abilities crucial for the devel- opmental process. Integral to the model is deliberate practice, which is defined as training activities that are undertaken specifically to improve performance, foster positive skill development, and require cognitive and physical effort (18). Deliberate practice was viewed as an important attri- bute of realizing future talent within the model proposed by Bailey and Morley (4). The authors cited the work of Schoon (4 6) in delineating that irrespective of a child's ability, with- out both generic and specialized forms of learning, individ- uals will be excluded from a range of opportunities and thus their talent development will be stymied. However, despite the importance of deliberate practice, the authors also pro- posed that talent development processes are completed in a holistic manner to maximize the chances of youth remain- ing engaged in physical activity (4).

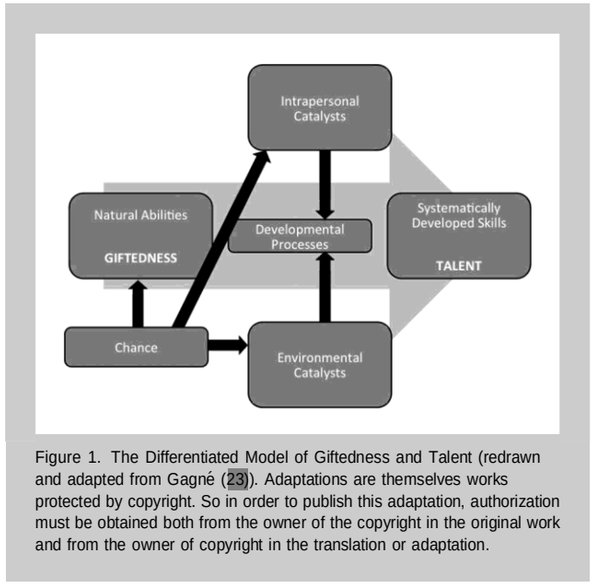

Figure 1. The Differentiated Model of Giftedness and Talent (redrawn and adapted from Gagné (23)). Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

The Developmental Model of Sports Participation (DMSP) identifies 3 distinct stages of development for youth: the sampling years (6–12 years), the specializing years (13–15 years), and the investment years (16 years onwards) (Ref. 13; Figure 2). Importantly, Côté et al. (13) encourage youth to sample a variety of sports during childhood and advocate a greater amount of time devoted to "deliberate play" during the sampling years as opposed to "deliberate practice." Deliberate play differs from the earlier definition of deliberate practice and refers to early exploratory physical activities that are intrinsically motivated and primarily geared towards maximizing enjoyment and fun (13). In the

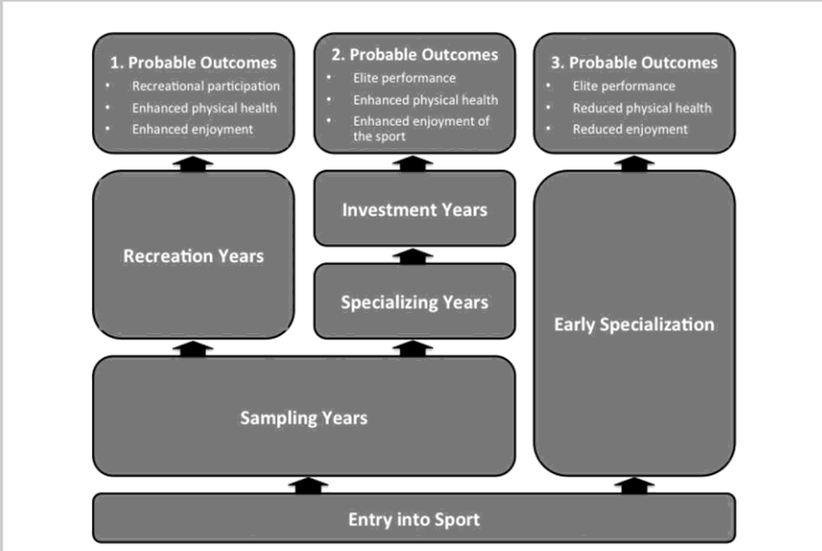

Figure 2. The Developmental Model of Sports Participation (DMSP) (redrawn and adapted from Côté and Vierimaa (15)). Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

International Society of Sport Psychology position stand on sampling or specialization (14), it is suggested that:

- Sampling does not hinder elite development in sports where peak performance is achieved after maturation.
- Sampling is linked to longer sporting careers and has positive implications for long-term sport participation.
- Sampling favorably affects positive youth development.
- Deliberate play provides a foundation of intrinsic motivation.
- Deliberate play establishes a range of motor and cognitive experiences.

Sampling and deliberate play provide the foundation for participants following a performance pathway to then specialize in fewer sports with more deliberate practice and ultimately invest in a single sport. Sampling and deliberate play also provide the building blocks for an alternative pathway to continued participation in sport through the recreation years (13 years old onwards), which is characterized by continued deliberate play and a focus on health, fitness, and personal development (4,14,15).

Application of Talent Development Theory to Athletic Development Models. Although terminologies and approaches to programming vary between models of talent development, some consistent philosophies exist that could be of use for establishing standardized long-term youth athletic development.

- Youth development should be grounded in the learning process as opposed to short-term outcomes. This is especially important to eliminate the risk of practitioners seeking short-term gains in, for example, physical fitness at the expense of technical competency.
- Children should be exposed to a variety of sports and activities geared towards deliberate play during the early stages of childhood. Practitioners can use this philosophy to ensure that youth are exposed to a range of experiences (i.e., different coaches, different modes of training and competition, different movement patterns within different sports) and opportunities to engage in athlete-led exploratory play to ensure the development of a well-rounded and physically literate child or adolescent.
- Models acknowledge the role of deliberate practice. In addition to sampling different sports and activities during the formative years, children and adolescents will need an element of repetition within their training programs to aid motor control and overall athletic development. Youth will also require qualified coaching, meaningful instruction, and constructive feedback from pediatric practitioners, and will need to view the process of athletic development as a lifelong commitment to physical activity.

Athletic Development Models

The long-term athlete development (LTAD) model (5,6) has been adopted by a number of sporting associations world- wide in an effort to more closely align training prescription with the timing and tempo of maturation as opposed to chronological age. Basing youth training prescription solely on chronological age will typically restrict optimal program- ming for youth of different maturational stages (31). Balyi (5,6) stated that the LTAD model is driven by participant development and that, with a foundation in physical literacy (commonly termed movement competency), an individual can opt out at any stage of the model but remain within a recreational lifelong physical activity pathway (10). How- ever, given the use of the term “athlete” within the title and its specific directives to maximize physical development, the model would seem more closely aligned with developing sports performance potential rather than general participa- tion levels. For example, the “Learning to Train” and

"Training to Train" stages have been characterized as the periods that "make or break the athlete" (6). Irrespective of whether the model's focus is governed by the development of participation or talent, the LTAD model has advanced the field of youth training. The LTAD model has highlighted the importance of considering individual variations in biological maturation instead of chronological age when programming for youth, as well as starting the training process in early childhood.

Despite the general acceptance of the LTAD model by sporting associations, NGBs and within the coaching literature in general, recent criticisms from the academic fields have questioned its rigid view of athletic development and the fact that the model lacks any real empirical evidence. Concerns exist around the distinct lack of substantive evidence to support the concept of "windows of opportunity," in which the founders of the LTAD model stated must be exploited to enable a child to reach their athletic potential (3,21). Importantly, although children and adolescents do experience naturally occurring periods of accelerated adaptation during the developmental years, the interaction of training stimuli with age, growth, and maturation remains unclear (4 4).

Another criticism of the LTAD model is its adoption of the 10,000-hour rule, which suggests that an individual seeking to acquire expertise in a given activity must engage in 10,000 hours (or 10 years) of deliberate practice. This recommendation is supposedly based on research that examined the development of expert musicians (19). Interestingly, an editorial by Ericsson (18) highlights how his earlier work has actually been misconstrued in recent times, citing that expert performance does not simply require the accumulation of 10,000 hours of deliberate practice and that the focus should not be placed on simply accruing a set number of hours in any given activity. Furthermore, researchers have shown that late specialization and reduced levels of specific training during childhood are significant predictors of elite performance in adulthood (36). Researchers have also shown that youth who participate in a greater breadth of sports at a younger age performed better in gross motor coordination tasks and had a reduced injury risk in comparison with children who specialized in a single sport at an early age (22,24). Given the adoption of the LTAD model by so many organizations around the world, the misnomer surrounding the 10,000 hours rule has potentially major implications for existing long-term athletic development pathways. In addition to the concerns surrounding early specialization, 10,000 hours should not be used as a guide for athletic development pathways as it goes directly against the concept of individualized program design, which will be inherently different for each child or adolescent.

More recently, researchers created the Youth Physical Development (YPD) model (Ref. 30; Figures 3A, B), which used existing empirical research from the development of individual components of fitness to establish an overall long-term strategy for physical development across childhood and adolescence. The introduction of the YPD model moved away from "athlete-centered" terminology to place emphasis on the long-term development of physical abilities for all youth. In contrast to the theories of trainability associated with the LTAD model (6), Lloyd and Oliver (30) show that all fitness components are trainable at all stages of development; however, the mechanisms responsible for the magnitude of adaptive changes are likely to differ with maturation. The timing, tempo, and magnitude of maturation will also vary between children, which further emphasize the need for individualization of training prescription from any child or adolescent. Additionally, central to the YPD model is a primary emphasis on the development of muscular strength and movement competency for both children and adolescents. The development of movement competency is characterized by an early bias towards enhancing fundamental movement skills with a transition over time towards a greater emphasis on sport-specific skills. Early exposure to resistance training is supported by research, which shows that muscular strength development from resistance training can enhance physical performance (29), improve markers of health and well-being (such as insulin-sensitivity (47) and levels of adiposity (8)) in active and inactive youth, and reduce the risk of sports-related injury (17,35,38,55). Additionally, movement skill competency is associated with physical activity engagement and improved measures of health and well-being in both normal and overweight/obese youth (11,28,32). Therefore, practitioners should view the central philosophies of the YPD model as appropriate for all youth irrespective of their level of participation in organized sport or recreational physical activity.

Summary of Athletic Development Models. Although terminologies and approaches to programming vary between models of talent development, some consistent philosophies exist that could be of use for establishing standardized long-term youth athletic development.

- Athletic development programs should be grounded in developing movement competency and muscular strength. Practitioners must be cognizant that youth must have well-developed movement mechanics and appropriate levels of muscular strength to prepare them for the demands of sport and/or recreational activity.
- Athletic development programs should not be designed in accordance with "windows of adaptation." Researchers have clearly shown that both children and adolescents can make worthwhile gains in a range of physical fitness components throughout the growing years. Although youth do experience periods of accelerated adaptation, it is inappropriate to base athletic development program design on the theory of "windows of adaptation" due to a significantly limited evidence base.
- Athletic development programs should not be designed to primarily accumulate 10,000 hours of deliberate practice.

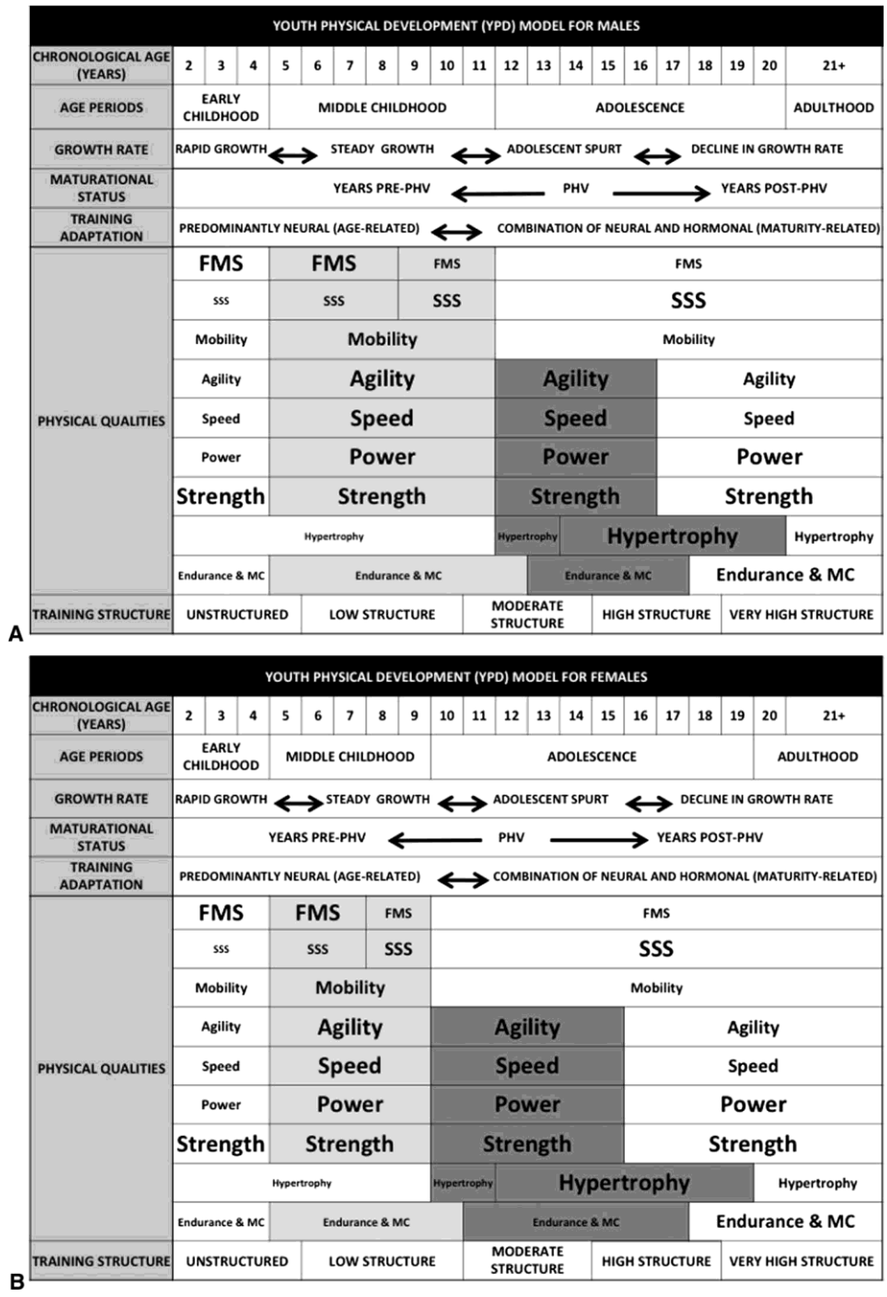

Figure 3. A) The youth physical development model for males (reprinted with permission from Lloyd et al. (31)). Note: Font size refers to importance; light blue boxes refer to preadolescent periods of adaptation, dark blue boxes refer to adolescent periods of adaptation; PHV = peak height velocity; FMS = fundamental movement skills; SSS = sport-specific skills; MC = metabolic conditioning. B) The youth physical development model for females (reprinted with permission from Lloyd et al. (31)). Note: Font size refers to importance; light pink boxes refer to preadolescent periods of adaptation, dark pink boxes refer to adolescent periods of adaptation; PHV = peak height velocity; FMS = fundamental movement skills; SSS = sport-specific skills; MC = metabolic conditioning. Adaptations are themselves works protected by copyright. So in order to publish this adaptation, authorization must be obtained both from the owner of the copyright in the original work and from the owner of copyright in the translation or adaptation.

Training programs should be individualized owing to differing rates of growth, maturation, development, and skill mastery. Consequently, it is counterintuitive to assume that all children require the accumulation of a rigid 10,000 hours of focused practice to achieve expertise in a sport or activity.

Realities of Developmental Models

T1 Table 1 provides a summary of the models relating to both talent and athletic development, highlighting the benefits and disadvantages associated with each philosophy. Developmental models (both talent and athletic) are designed to provide structure and guidance to practitioners working with youth. However, they should not be viewed as gold standard blueprints, which can simply be superimposed on any athlete, especially given the need for more empirical evidence surrounding the trainability of youth and the unique vagaries surrounding growth and maturation. Although a range of models exist, which provide general strategies for either talent or athletic development, it is important to stress that models should be viewed as flexible blueprints as opposed to stringent directives. It is imperative that coaches (if deemed appropriate) tailor the generic guidelines proposed in models to best suit the unique and individual demands of the child or adolescent. For example, from an athletic development perspective, an adolescent with a low-training age and poor technical competency should not commence a high intensity highly skilled training program without first developing a broad range of movement skills and base levels of muscular strength. Similarly, a prepubertal child who possesses innate athleticism and technical competency should not be restricted to training modes typically associated with inexperienced children.

Merging Talent and Athletic Development: the Composite Youth Development (CYD) Model

To date, a blended model of both talent development and athletic development does not exist. The Composite Youth
F4 Development (CYD) model for males (Figure 4A) and females (Figure 4B) demonstrates how existing models of youth physical development (30) and talent development (13) can be adapted and integrated to provide an overall pathway for the holistic development of youth.

With reference to the "Talent Development" section of the model, the DMSP (13) has been adapted to provide a pro- gressive structure for long-term engagement in sports and physical activity. Conversely to the original DMSP, early childhood has been termed as the investment years owing to the fact that this stage of development is crucial for chil- dren to "invest" in the exploration and learning of a broad range of fundamental movement skills in fun-based learning environments that will serve as strong foundations for more advanced movement skills later in life. As child transitions through middle childhood and into early adolescence, they then enter into the sampling years, during which they are exposed to a range of different sports and activities that assist in the further development of the foundational skills that they acquired during the investment years. Finally, during adolescence, an individual will then typically choose to engage with competitive sport (specializing years) or simply remain in noncompetitive sports or recreational physical activity (recreation years). Importantly although, within the CYD model, the horizontal line that differentiates between the recreation and specializing years is dashed to represent the transitional nature of these 2 domains of talent development. For example, a child of approximately 14 years of age who does not initially specialize in competitive sport may be selected through a large-scale talent identification program later in their adolescent years. Alternatively, a child who opts to specialize in a single sport at age 14 may decide that they do not aspire to continue with that sport some years later but instead wish to remain involved with sports and physical activity purely from a recreational perspective.

Similarly to the earlier work of Lloyd and Oliver (30), within the "Physical Development" section of the newly proposed model, training emphasis is highlighted by font size (i.e., the greater the font size, the more importance is placed on training that particular fitness component); however, it is acknowledged that all fitness components are trainable at all stages of development. For an in-depth examination of the philosophy surrounding either the YPD model or the DMSP, readers are directed to Lloyd and Oliver (30) and Côté et al. (13).

A novel element of the CYD model is that it also attempts to provide a structured approach for "Psychosocial Development." Within the model, key psychosocial parameters are identified that practitioners should consider when structuring the development programs for children and adolescents. Although limited data exist related to strategies for developing psychosocial qualities in youth at different stages of maturation, a recent review has provided relevant considerations and best practices for mental training with young athletes (57) from which guidance for the content of the CYD model has been based on. It should be noted that many other important psychosocial parameters exist for each stage of development, and those selected for the CYD model are based on the available literature and personal experiences of the authorship team. However, irrespective of the stage of development, the key goal of any practitioner working with youth should be to ensure the child or adolescent re- mains motivated for lifetime engagement with sports and physical activity.

For the purposes of this review, the CYD model will briefly be discussed in relation to the different stages of development from childhood to the onset of adulthood (early childhood, middle childhood, and adolescence).

Early Childhood

Initially, the CYD model denotes that during early childhood, children should be introduced to movement and play

TABLE 1. Summary of existing models of practice.

Model	Model orientation	Source of origin	Central philosophy	Benefits	Disadvantages
Differentiated model of giftedness and talent (23)	Talent	Education	Systematic learning integral to translate gift into talent	Focused on developing a multitude of aptitudes	Does not provide guidance on exercise prescription to practitioners
Model of talent development in physical education (4)	Talent	Education	Combination of deliberate practice and generic learning required to develop talent	Multidimensional approach to talent development (psychomotor, interpersonal, intrapersonal, cognitive, and creative abilities)	Does not provide guidance on exercise prescription to practitioners
Developmental model of sports participation (15)	Talent	Education/elite sport	Youth should sample a range of different sports before specializing and investing in later years	Supports the notion of late specialization and youth experiencing a range of sports early in life	Although a participant development model, it is based on interviews with elite athletes. Does not provide guidance on exercise prescription
Long-term athlete development model (6)	Athleticism	Biological development/ elite sport	Early engagement in physical activity; take advantage of "windows of opportunity"	Attempts to base exercise prescription on biological maturation as opposed to chronological age	Due to its title, the model seems to be focused on developing athletes. Also, its guidance on exercise prescription to practitioners is limited and lacks validity
Youth physical development (31)	Athleticism	Biological and training age/ athletic development for all youth	All fitness components are trainable at all stages of development and importance of early exposure to age-appropriate training	Provides rationale for exercise prescription based on available literature. Highlights importance of muscle strength and motor skill development. Stresses importance of biological maturation and training age for prescription	Focuses solely on the development of physical athleticism

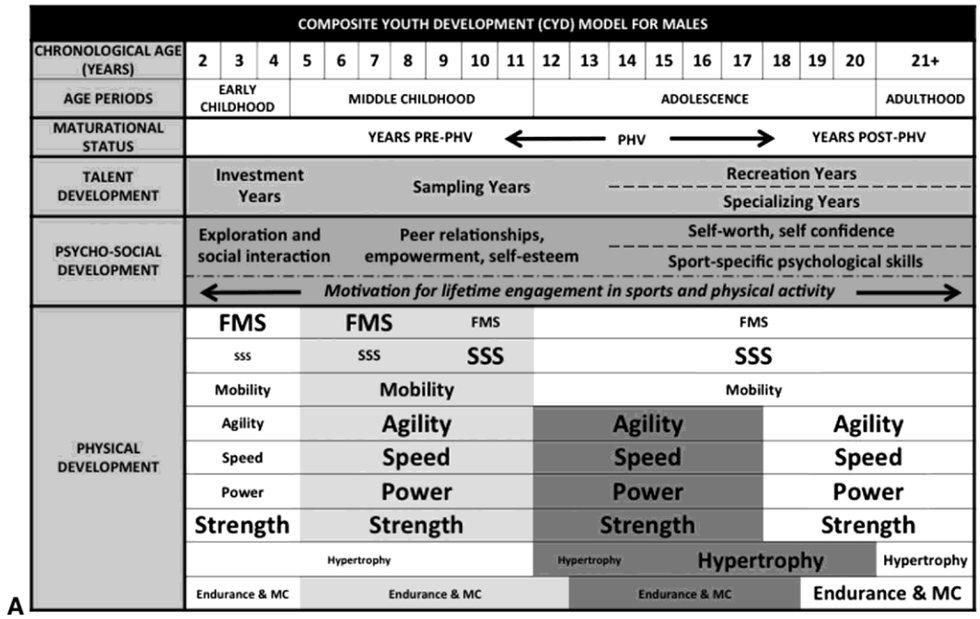

Figure 4. A) The composite youth development model for males. Note: Font size refers to importance; light blue boxes refer to preadolescent periods of adaptation, dark blue boxes refer to adolescent periods of adaptation; PHV = peak height velocity; FMS = fundamental movement skills; SSS = sport-specific skills; MC = metabolic conditioning. B) The composite youth development model for females. Note: Font size refers to importance; light pink boxes refer to preadolescent periods of adaptation, dark pink boxes refer to adolescent periods of adaptation; PHV = peak height velocity; FMS = fundamental movement skills; SSS = sport-specific skills; MC = metabolic conditioning.

activities that predominantly develop fundamental movement skills and primal levels of muscular strength at a time where the neuromuscular systems of children are highly plastic. Such activities should be designed in a fairly unstructured and exploratory style environment to mirror the limited time that very young children remain engaged with

an activity. At this stage of childhood, fundamental movement skill development may need to be masked within fun-based activities (e.g., exposing children to games/activities that require them to dynamically manage body weight within space). From a psychosocial perspective, it is suggested that the main emphasis of any program at this stage of development should be on promoting fun and social interaction to help young children enjoy the learning of new skills and to encourage the interaction process with their peers.

Middle Childhood

During middle childhood, children enter the sampling years where they are encouraged to experience a breadth of sporting activities and to avoid specializing early in a single sport. All fitness qualities should be trained in an integrated manner at all stages of development; however, priority should still be given towards enhancing fundamental movement skill competency and muscular strength levels. While during early childhood, athletic development sessions may not take place in fully operational strength and conditioning facilities, it is hoped that towards the end of this stage of development, children could (and should wherever possible) be comfortable with all components of a strength and conditioning facility, including weightlifting platforms, plyometric boxes, use of bands, etc. Given that children become more cognizant of their peers towards the end of middle childhood, it is suggested that enhancing self-worth and self-esteem in children at this stage of development is important to offset the potential negative consequences of peer comparison. It is also worthwhile to empower youth of this age wherever possible to ensure they begin to take responsibility for their own learning process.

Adolescence

Adolescence is a stage of development during which youth may begin to specialize in a particular sport (specializing years). During these years, practitioners should continue to foster peer relationships among youth, enhance self-esteem, and seek to empower youth at all times. Towards the end of adolescence, it is likely that sport-specific psychological skills will be developed in young athletes in an attempt to maximize sporting performance. Youth who remain in competitive sport systems will eventually take advantage of their already well-developed levels of skill and athleticism and begin to follow very highly structured sport-specific talent development programs. It is imperative that young athletes continue to engage in appropriately designed strength and conditioning programs during adolescence, and these are likely to be highly tailored to the athlete depending on their individual needs and the specific demands of their chosen sport. However, muscular strength and skill competency remain key components of any training program at this stage for both performance and injury prevention reasons.

Adolescence may also serve as a period during which youth decide to opt out of competitive sport but instead continue to participate in recreational activity up to and into adulthood (recreational years). During this stage of development, youth should still be encouraged to engage in activities that develop a range of fitness qualities and that enable them to achieve the recommended exposure to daily moderate-to-vigorous physical activity (60). However, it is also crucial that wherever possible, such activities provide a suitable training stimulus that reduces their risk of injury and prepares them for the demands of exercise. From a psychosocial perspective, it is imperative that youth that are not engaged in competitive sport continue to have the necessary levels of self-worth and self confidence to remain motivated for lifetime engagement in recreational sports and physical activity.

Summary

Existing models of development have provided a structured framework for coaches to consider for maximizing the athletic potential of youth (6,30). While the development of these models has enabled coaches to appreciate the interaction between growth, maturation, and training, our understanding of the trainability of youth requires more research, reflected by the current lack of a longitudinal empirical evidence base. Research is also necessary to ensure that sporting associations and public health agencies that are responsible for exercise prescription for youth are delineating their guidelines based on empirical evidence wherever possible. This article has proposed a new composite model that has attempted to integrate the philosophies of talent, physical, and psychosocial development. As with all other models, the CYD model should be viewed as a flexible blueprint as opposed to a rigid structure, from which coaches can work to promote a holistic approach to the development of all youth. Practitioners must ensure that youth are provided with individualized programs that enable development commensurate with the specific needs of each participant and that motivate all youth for lifetime engagement with sports and physical activity.

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