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Sports Specialization and Intensive Training in Young Athletes

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abstract

Sports specialization is becoming the norm in youth sports for a variety of reasons. When sports specialization occurs too early, detrimental effects may occur, both physically and psychologically. If the timing is correct and sports specialization is performed under the correct conditions, the athlete may be successful in reaching specific goals. Young athletes who train intensively, whether specialized or not, can also be at risk of adverse effects on the mind and body. The purpose of this clinical report is to assist pediatricians in counseling their young athlete patients and their parents regarding sports specialization and intensive training. This report supports the American Academy of Pediatrics clinical report "Overuse Injuries, Overtraining, and Burnout in Child and Adolescent Athletes."

INTRODUCTION

Youth sports culture has changed dramatically over the past 40 years. It is less common today to see a group of young children congregate in a neighborhood to play a "pick-up" game without any adult influence. The norm has become for children and adolescents to participate in organized sports driven by coaches and parents, often with different goals for the game than its young participants. It is also less common now to have a multisport athlete in middle or high school, because the norm has become for young athletes to specialize in a single sport at younger ages. There is increased pressure to participate at a high level, to specialize in 1 sport early, and to play year-round, often on multiple teams. This increased emphasis on sports specialization has led to an increase in overuse injuries, overtraining, and burnout.

This clinical report replaces a previous American Academy of Pediatrics (AAP) policy statement entitled "Intensive Training and Sports Specialization in Young Athletes"[1] and is complementary to the AAP clinical report "Overuse Injuries, Overtraining, and Burnout in Child and Adolescent Athletes."[2] This report reviews the epidemiology of youth sports and the background of specialization, highlights specific physiologic concerns with intensive training, answers

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specific questions pertaining to sports specialization in athletes <18 years, and offers guidance for pediatricians to help their young athlete patients and their parents (Figure 1).

EPIDEMIOLOGY AND BACKGROUND

Participating in sports provides many benefits for youth, including developing lifelong physical activity skills, socializing with peers, building teamwork and leadership skills, improving self-esteem, and having fun. According to the 2008 National Council of Youth Sports' report on trends and participation in organized youth sports, 60 million youth aged 6 through 18 years participated in organized sports, which is an increase from 45 million in 1997.[3] The sex ratio has remained constant, with 66% of young athletes being male and 34% being female.[3] Of the 60 million young athletes reported, 27% participated in only 1 sport.[3] Participation by children aged ≤6 years increased from 6% in 1997 to 12% in 2008.[3–5] Unfortunately, 70% of children drop out of organized sports by 13 years of age.[6] According to the 2013–2014 high school athletics participation survey from the National Federation of High School Sports, 7.8 million high school students participated in sports.[7] These statistics are an underestimate of actual participation rates, because they only represent athletes who participate in the organized sports surveyed or from high schools that are members of the National Federation of High School Sports. The actual incidence of overuse and overtraining injuries is difficult to assess because of the lack of uniformity and agreement throughout the literature in the definitions used. According to some reports, overuse injuries account for 46% to 50% of all athletic injuries.[8–10] In high school athletes alone, overuse injuries represented

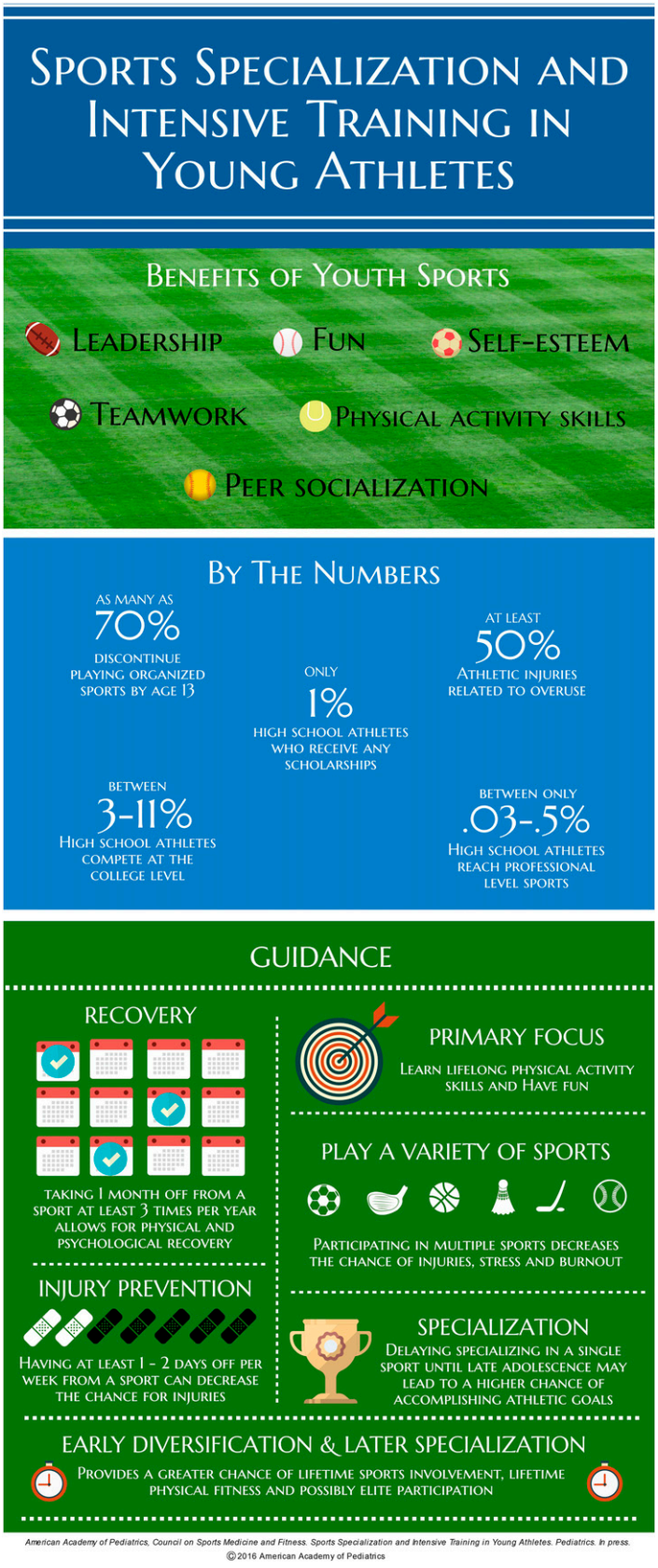

FIGURE 1
Sports Specialization and Intensive Training in Young Athletes.

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7.7% of all injuries.[11] Actual injury rates vary by age, sex, and sport. Currently, no data are available on how many young athletes play year-round or on multiple teams at the same time.

Sports specialization occurs when an athlete focuses on only 1 sport, usually at the exclusion of any other and often year-round. Sports specialization appears to have increased overall, along with earlier onset, because select or travel leagues start as young as 7 years of age.[5,12,13] These leagues often are independent of school-sponsored programs and foster year-round single-sport participation.[14] Sports specialization can be divided into early specialization (ie, before puberty) and late specialization with early diversification (sampling).[4,13,15–17] The reasoning behind sports specialization is varied and includes aspirations to be one of the few who obtain a college scholarship or the even fewer who make it to the elite level of the Olympics or professional status.[4,13] Some young athletes desire to be identified as talented by coaches, the media, the sporting industry, and society as a whole.[4,13]

Year-round training in 1 sport has become more common for young athletes. Often, the motivation is for the athlete and parent to capture a piece of the very small "pie" leading to college scholarships and a professional career. Only 3.3% to 11.3% of high school athletes compete at the National Collegiate Athletic Association (NCAA) level, and only 1% receive an athletic scholarship.[4,18] In addition, only 0.03% to 0.5% of high school athletes make it to the professional level.[18] Athletes who participate in a variety of sports have fewer injuries and play sports longer than those who specialize before puberty.[1,2,4,5,19,20]

Sometimes, these are the goals of the parent and/or coaches and not necessarily the athlete. Studies have shown that parents were the strongest influence on starting a sport, and coaches influenced the decision to train intensely and specialize in a sport.[5,12,21] Even when the athlete is driven to take his or her game to the next level, evidence is mounting that specialization in a single sport before puberty may not be the best way to accomplish this goal for the majority of sports.

ATHLETE DEVELOPMENT

Long-term athlete development (LTAD) programs, which started in the 1990s in the United States, Canada, and other industrialized countries, have tried to counter the detrimental effects of early specialization and year-round sports by offering a positive framework to develop physical literacy and elite athletes.[16,22] Physical literacy has been defined as the mastering of fundamental movement skills and fundamental sports skills.[23] The ABCs (agility, balance, coordination, speed) are the basic skills required for physical literacy.[23] The shortfall of LTAD programs is that they have been based mostly on empirical evidence and are not individualized plans.[24] Many countries have also used these programs as a way to develop elite talent, thereby nurturing the rare minority instead of promoting physical activity for the great majority, as other programs promote.[25]

Five stages have been described for the late-specialization model of LTAD and include the following[16]:

1. FUNdamental
2. Training to Train
3. Training to Compete
4. Training to Win
5. Retirement/Retraining

The goal of the FUNdamental stage is to learn the fundamental movement skills and the ABCs of athleticism.[16] This stage should occur in 6- to 10-year-olds by using a positive and fun approach.[16] The Training to Train stage occurs in 10- to 14-year-olds with the goal of learning how to train and learning the basic skills of a specific sport.[16] In the Training to Train stage, there should be a ratio of 75% training to 25% competition, with the major focus on learning the basics as opposed to competition.[16] The Training to Compete stage occurs in 13- to 18-year-olds, with 50% of the time spent in developing technical and tactical skills and the other 50% on competition-specific training.[16] The Training to Win stage occurs in athletes aged ≥17 years, with the focus of training to optimize performance, with 75% of the time spent in competition (either competition-specific training activities or competitions themselves).[16] The Retirement/Retraining stage occurs when athletes stop competing permanently and possibly move into sports-related careers (ie, officiating, administration, coaching).[16] Physical and mental burnout is prevented through "prophylactic" breaks in training.[16] Athletes who decide not to continue competitive sports will still benefit from their FUNdamental stage accomplishments during their recreational activities.

The US Olympic Committee, along with National Governing Bodies, used the LTAD principles to create the American Development Model in 2014.[26] The 5 stages they created include the following:

1. Discover, Learn, and Play (ages 0–12 years)
2. Develop and Challenge (ages 10–16 years)
3. Train and Compete (ages 13–19 years)
4. Excel for High Performance or Participate and Succeed (ages ≥15 years)
5. Mentor and Thrive (for Life)[27]

Another model of sports expertise development that has been proposed

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is the Developmental Model of Sport Participation.[15,17,28] Two distinct pathways include either early diversification (sampling) or early specialization. The main tenants of early diversification include involvement in multiple sports and participation in deliberate play.[15,17,28] The benefits of early diversification include "experiencing different physical, cognitive, affective and psycho-social environments."[15] The foundational skills acquired are necessary to allow the athletes to successfully specialize later.[29] Diversification also allows children to experience different social interactions with peers and adults and reinforces emotional and self-regulating skills needed for the future.[15,17] "Deliberate play" has been defined as the intentional and voluntary nature of informal sport games designed to maximize inherent enjoyment.[15] Examples of deliberate play include the once common basketball in the park and backyard baseball games usually organized by children. Athletes are less likely to drop out of organized sports if they participate in informal games and sports.[29] In contrast, early specialization involves focusing on 1 sport with an emphasis on deliberate practice and very little deliberate play while focusing on performance as early as 6 years old.[15,28] "Deliberate practice" has been defined as "a highly structured activity that requires effort, generates no immediate rewards, and is motivated by the goal of improving performance rather than inherent enjoyment."[30] Early specialization assumes "talented" children can be selected early and uses a training regimen that is usually not in accordance with the child's motivation to participate in sports.[15]

Early specialization programs are designed to produce elite-level athletes, as opposed to early diversification programs, which focus on the long-term needs of children through enjoying various activities and play.[15] Early diversification has a greater potential of minimizing dropouts while maximizing sustained participation, fostering positive peer relationships and leadership skills, and creating intrinsic motivation through participation in enjoyable activities.[15,17]

PHYSIOLOGIC AND PSYCHOLOGICAL CONCERNS WITH INTENSIVE TRAINING

Intensive training in young athletes, whether specialized or not, may potentially affect various components of their health, including cardiac, nutrition, maturation, musculoskeletal, and psychological. Musculoskeletal and psychological effects of intensive training in young athletes were covered in great detail in reports by the AAP and the American Medical Society for Sports Medicine.[2,19,20]

No studies have shown any adverse effects of intense training on the cardiovascular system of young athletes, although the number of studies is limited.[31–33] Athletes of all ages need to have a proper diet that includes an adequate amount of calories from proper sources as well as iron, calcium, and vitamin D to meet their training needs.[34] Young athletes have an additional burden because of the increased needs related to growth. The iron and calcium needs of the body are highest during the growing phases of a child and an adolescent. There is support for closely monitoring nutritional intake in all youth athletes, especially those who participate in high-intensity and endurance sports, focusing particularly on caloric intake required to meet the demands of training as well as to maintain adequate growth and development.[35]

Some female athletes experience menarche 1 to 2 years later than nonathletes but still within the normal range.[36,37] Theories proposed for this difference include lower body fat, training, stress, undernutrition, or a sport-specific preselection bias.[37–40] Secondary amenorrhea can result from low energy availability attributable to an imbalance between energy expenditure and caloric intake. Because of the increased risk of stress fractures and lower bone density, female athletes should be monitored for amenorrhea and treated appropriately. All female athletes are at risk of developing the female athlete triad (low energy availability, menstrual dysfunction, and low bone mineral density),[35] and pediatricians should screen routinely for signs of the triad in active young females. No studies in young male athletes have shown any adverse effects on pubertal growth and maturation or adult height from intense training.[41,42]

SPORTS SPECIALIZATION

Does Specialization Lead to a Successful Performance and Career?

Most authorities agree that sports specialization, in general, leads to higher athletic "success," but the optimal timing of specialization is only now becoming clearer. Studies have shown that Division 1 NCAA athletes are more likely to have played multiple sports in high school and that their first organized sport was different from their current one.[4,43] Many examples exist of professional athletes who have learned skills that cross over to their sport by playing a variety of sports into high school and even college. There were 322 athletes invited to the 2015 National Football League Scouting Combine, 87% of whom played multiple sports in high school and 13% of whom only played football.[44] Other studies in elite athletes have shown that intense training did not start until late adolescence and that these athletes played other sports before specializing.[45,46] Reviews of studies

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of elite athlete specialization history by Jayanthi et al[5] and Côté et al[15] revealed that, for the majority of sports, late specialization with early diversification is most likely to lead to elite status. In addition, athletes who engaged in sport-specific training at a young age had shorter athletic careers.[15]

It has often been misquoted that to succeed, an athlete needs to have 10 000 hours of practice/competition over 10 years. The media have incorrectly extrapolated Ericsson and co-workers' studies of chess players to a formula for sports success.[30,47] Many examples exist of successful athletes who have <10 000 hours and others who have not succeeded despite having >10 000 hours of practice/competition. Other factors come into play besides sports exposure time. These may include physiologic construction (ie, a high jumper with elastic Achilles tendon) and genetic constitution.[48] For some athletes, elite status may be achieved with 10 000 hours of total deliberate play and deliberate practice time in all sports combined but only 3000 hours of sport-specific training.[28,48] Evidence is lacking that specialization before puberty is necessary to achieve elite status, and in fact, specialization before puberty is more likely to be detrimental.[5]

When Is It Appropriate and Safe to Specialize?

Current evidence suggests that delaying sport specialization for the majority of sports until after puberty (late adolescence, ~15 or 16 years of age) will minimize the risks and lead to a higher likelihood of athletic success.[4,5,13,19,20,29,49] Only 0.3% of German athletes in Olympic sports selected at the youngest level were ranked internationally, and most elite athletes specialized in their primary sport later in life.[4,46] Specialization can be divided into early versus late, with the inclusion of early diversification of multiple sports for those who specialize later. Early diversification allows the athlete to explore a variety of sports while growing physically, cognitively, and socially in a positive environment and developing intrinsic motivation.[4,5,15,29,46,50] Young athletes can learn many important fundamental physical movement skills (ABCs) with early diversification that can then transfer over to their primary sport if they decide to specialize later.[51] By learning these skills during their developing years through deliberate play, athletes will require less deliberate practice to acquire expertise in their chosen sport.[5,15] Studies have also shown that deliberate play is crucial to normal development and attainment of elite status.[5,24] Athletes in late adolescence have the cognitive, physical, social, emotional, and motor skills needed to invest into highly specialized training.[15] They can understand the benefits and costs of intense focus on 1 sport and, just as importantly, are able to make an independent decision about investing in 1 sport.[15,29]

What Are the Risks in Specializing Too Soon or at All?

Young athletes who specialize too soon are at risk of physical, emotional, and social problems.[2,4,5,14,19,20,49] Athletes may become socially isolated from their peers and may have altered relationships with family, overdependence on others with a loss of control over their lives, arrested behavioral development, or socially maladaptive behaviors.[4,14] Specializing early with intense training can lead to overuse injuries, which can cause pain and temporary loss of playing time or may lead to early retirement from the sport.[2,4,5,19,20,29,49] The risk of injury is multifactorial, including training volume, competitive level, and pubertal maturation stage.[5,8] One study in high school athletes showed an increased risk of injury when the training volume exceeded 16 hours per week.[52] Another study determined that sports specialization was an independent risk factor for injury and that athletes who participated in organized sports compared with free play time in a ratio of >2:1 had an increased risk of an overuse injury.[49] This same study found that young athletes who participated in more hours of organized sports per week than their age in years also had an increased risk of an overuse injury.[49] Burnout, anxiety, depression, and attrition are increased in early specializers.[2,4,5,13,19,20,53] Social isolation from peers who do not participate in the athlete's sport and lack of being exposed to a variety of sports also are concerns.[4,14] Restriction in exposure to a variety of sports can lead to the young athlete not experiencing a sport that he or she may truly enjoy, excel at playing, or want to participate in throughout his or her adult life. An additional concern is the risk of physical, emotional, and sexual abuse by the adults involved in the young athletes' lives as a result of overdependence.[4,14] Dietary and chemical manipulation are also possible.[4,14,54,55] The combination of these adverse outcomes could lead to a decrease in lifelong physical activity.[13]

Which Sports Require Early Specialization and Are Those Athletes at High Risk?

Figure skating, gymnastics, rhythmic gymnastics, and diving may require early specialization, because peak performance occurs before full physical maturation.[4,16,56] However, it is not known whether the training required for such sports poses a risk for athletes' long-term health and well-being.[29] Studies in gymnasts and figure skaters found that their training did not affect pubertal growth and maturation or adult height.[37,42] Menarche occurred later but within a normal range.[36,37] However, other studies have shown that female

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athletes who participate in sports requiring early sports specialization are at higher risk of overuse injuries as well as the female athlete triad.[35]

How Much Training Is Adequate to Succeed Versus Too Much?

The exact amount of training needed to succeed has not been described. The threshold to avoid injuries, burnout, and attrition has not been elucidated. The possible rule of participating in fewer hours of organized sports per week than their age in years[49] or restricting training to <16 hours per week[52] to decrease the chance of injuries needs to be validated by other long-term studies.

Do Sports-Enhancement Programs Lead to Success?

Young athletes need to learn motor development skills, social skills, and psychological skills to succeed. No studies on sports-enhancement programs in youth that only teach sport technique or "conditioning" have shown a greater chance of success despite their increased time and financial investment.

What Are the Effects of Early College Recruitment?

Talented youth are starting to be ranked nationally as early as sixth grade.[4] As colleges start to look at middle school and early high school athletes, more pressure is created for the athlete and parent to do everything possible to succeed. This situation may push athletes into playing year-round and possibly on multiple teams simultaneously to get more exposure and specializing in a single sport sooner for fear of missing their opportunity to impress a college coach. Given what is currently known about early sport specialization, this changing paradigm should be discouraged by society. The AAP, NCAA, pediatricians, parents, and other stakeholders should advocate banning national ranking of athletes and college recruitment before the athletes' later high school years.

FUTURE DIRECTIONS

Are there genetic factors that predict success or failure of a young athlete? Success is dependent on multiple factors, with genetics playing a part.[57] It is not uncommon that an Olympic or professional athlete has an immediate relative who also played at a very high level.[48] The exact make-up of a sports gene that would guarantee athletic success has not been described, if it even exists at all.

There is a need for longitudinal data on early sport specialization and intensive training that quantify injury and burnout rates. In addition, data are needed to confirm when specialization should occur, if at all.

GUIDANCE FOR THE PEDIATRICIAN

When a pediatrician encounters athletes younger than 18 years who are considering specialization or have already specialized, the following guidance for the athlete, parents, and coaches can be helpful.

1. The primary focus of sports for young athletes should be to have fun and learn lifelong physical activity skills.
2. Participating in multiple sports, at least until puberty, decreases the chances of injuries, stress, and burnout in young athletes.
3. For most sports, specializing in a sport later (ie, late adolescence) may lead to a higher chance of the young athlete accomplishing his or her athletic goals.
4. Early diversification and later specialization provides for a greater chance of lifetime sports involvement, lifetime physical fitness, and possibly elite participation.
5. If a young athlete has decided to specialize in a single sport, discussing his or her goals to determine whether they are appropriate and realistic is important. This discussion may involve helping the young athlete distinguish these goals from those of the parents and/or coaches.
6. It is important for parents to closely monitor the training and coaching environment of "elite" youth sports programs[14] and be aware of best practices for their children's sports.
7. Having at least a total of 3 months off throughout the year, in increments of 1 month, from their particular sport of interest will allow for athletes' physical and psychological recovery. Young athletes can still remain active in other activities to meet physical activity guidelines during the time off.
8. Young athletes having at least 1 to 2 days off per week from their particular sport of interest can decrease the chance for injuries.
9. Closely monitoring young athletes who pursue intensive training for physical and psychological growth and maturation as well as nutritional status is an important parameter for health and well-being.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
ABCs: agility, balance, coordination, speed
LTAD: long-term athlete development
NCAA: National Collegiate Athletic Association

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