The Risks of Sports Specialization in the Adolescent Female Athlete

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ABSTRACT

SINGLE-SPORT SPECIALIZED TRAINING HAS LED TO AN EMERGING RISK OF OVERUSE INJURY AND BURNOUT. HOWEVER, MUCH OF THE ATTENTION ON THIS TOPIC HAS FOCUSED ON YOUNG MALE ATHLETES WITH LIMITED DATA AVAILABLE ON FEMALES. THE PURPOSE OF THIS ARTICLE IS TO OUTLINE THE POTENTIAL RISKS AND SPORTS-SPECIFIC TRENDS IN THE ADOLESCENT ATHLETES, WITH AN EMphasis ON SPORTS SPECIALIZATION IN FEMALES. THERE IS EMERGING EVIDENCE OF AN INCREASE IN INJURIES AND OVERUSE INJURIES RELATED TO THE DEGREE OF SPORTS SPECIALIZATION IN FEMALE ATHLETES. ADOLESCENT FEMALE ATHLETES WHO SPECIALIZE IN A SINGLE SPORT AND PARTICIPATE IN INDIVIDUAL SPORTS SHOULD BE MONITORED FOR POTENTIAL INCREASED RISK OF OVERUSE INJURIES.

INTRODUCTION

Training young athletes today may involve high volumes and high intensities of practice and competition as well as specialization at younger ages. It is often coupled with a strong adult-driven emphasis from parents, coaches, and youth sports leagues on single-sport training at earlier ages for early and potential long-term successes. Although a singular definition of sports specialization is lacking, it may be considered year-round intense training in a single sport with the exclusion of other sports (13,14). The prevalence of early single-sport specialization seems to be greater today compared with more than 20 years ago; however, empirical data are lacking.

A more accurate description of sports specialization may encompass a multitude of training patterns seen in adolescent athletes and is best captured by a degree of specialization that has been previously published (14). Specifically, this degree of specialization may include 3 important components (year-round training for >8 months, focusing on a single main sport, and quitting all other sports to pursue a single sport) (14). Young athletes satisfying all 3 components may be considered highly specialized, whereas those with 2 of 3 components may be considered moderately specialized, and a low degree of specialization being assigned to those who have only 1 of these components (14).

Until recently, there has been very little evidence to establish rates of specialization in an athletic population, by sport or gender. Although “female-specific” issues such as the female athlete triad, anterior cruciate ligament (ACL) injury risk, and potential concussion risk have received recent attention, the relationship between sports specialization and gender has not been fully explored. Gender-specific training patterns have not been generally documented in young athletes, and the risks for overuse injuries as well as their relationship between gender and sports type has also had limited evidence. Patterns of overuse training in male-dominated sports such as baseball have received much more attention in the literature with outlining of “risk prone” pitching patterns and published guidelines for young pitchers who are invariably male (25). Similar data for young female athletes and, in particular, those involved in sports where females pre-dominate such as gymnastics, dance, and volleyball have not been examined to the same degree. Consequently, we will review the epidemiology of sports specialization, its influence on elite-level training, and risk for injury, including overuse-type injuries, as well as...
as its relationship to specific sports, as these issues pertain to the female athlete.

**EPIDEMIOLOGY OF SPORTS SPECIALIZATION AND RELATIONSHIP TO SUCCESS**

A comprehensive review of evidence-based counseling of young athletes and sports specialization was performed to elucidate whether there was any benefit to early specialized training (13). At the time of the review (2013), only athletes in rhythmic gymnastics began intensive specialized training before the age of 12 years. In all other sports, the elite athletes began these training patterns after the age of 12 years. There has been little evidence to support the notion that early specialized training patterns are beneficial to performance.

Previous work in musicians (violinists) by Ericsson et al. (7) suggested that there may be a dose-dependent response for sports-related outcomes to training load and talent level. Specifically, expert violinists had accumulated deliberate practice of approximately 10,000 hours compared with fewer hours of less-accomplished violinists. Ericsson’s research was highlighted in the popular book “Outliers: The story of success” by Malcolm Gladwell (8) where this “10,000 hours rule” was popularized, and more recently “The Sports Gene: Inside the science of extraordinary athletic performance” (5) where this concept was questioned. Ericsson defines deliberate practice as capacity to engage in “hard work” (6), and this theory was then applied to potentially improve the chances of young athletes achieving elite-level status.

Epstein (5), however, contends that each athlete is assigned a certain specific genetic makeup and that while you may be able to train to your personal limits, you cannot “overcome” your genetically assigned abilities. Within this context, there was no suggestion that early intensive single-sport training would be advantageous for performance versus diversified sports experiences. This theory has never been fully corroborated or researched in young athletes, but many achieve elite-level status with far less deliberate practice (11).

Other philosophies regarding sports specialization have emerged that describe different potential paths to becoming a specialized athlete. For example, Ericsson described several stages of becoming an expert, which included starting at an early age, specialized and increased practice, and dedicated full-time commitment (7). Côté et al. (2) similarly describes intense training fulfilling either (1) deliberate practice or (16) deliberate play. In an evaluation of elite youth hockey players, Soberlak and Côté (22) described 3 stages toward specialization: sampling (age 6–12 years), specializing (age 13–15 years), and investment (≥16 years).

DiFiori et al. (3) evaluated the role of sports specialization in the University of California at Los Angeles (UCLA) college athletes versus nonathletes and found the age of specialization to be no different. In fact, the most likely reason to participate in varsity athletics came from possible family environment factors, such as those with a first degree relative who participated in college or professional sports. Malina et al. (17) reported from a large university that college athletes were often more diversified before college except for those involved in individual technical sports. Until recently, there has been very little research investigating specific prevalence rates of sports specialization. Moreover, there has been little evidence regarding previous rates of specialization to outline any currently increasing trend. There had been no previous notice of this trend aside from a survey of athletic directors who suggested that sports specialization is more common now and that coaches are the most likely influence for this (10). In a recent cross-sectional evaluation of 1,191 athletes with a mean age of 14 years, 28% could be considered highly specialized, meeting all 3 criteria for specialization reported above (14). In an earlier study of 519 junior Midwest tennis players (15), the reported mean age of specialization was approximately 10.4 years, with nearly 70% of these tennis players specializing. By age 18 years, >95% of players specialized in only tennis. These 2 studies, however, contribute to what may be considered as a general lack of studies in this area.

**SPORTS-SPECIALIZED TRAINING AND RISKS OF INJURY**

There has been a genuine concern by many sports medicine organizations that this increase in sports specialization has the potential for increasing the risk of injury and burnout in young athletes (1,4,16). The American Academy of Pediatrics (AAP), the American Medical Society for Sports Medicine (AMSSM), and the American Orthopedic Society for Sports Medicine (AOSSM) all discouraged this practice. While recognizing that there are limited data, they advise against specializing in a single sport before adolescence (1,4,16). Jayanthi et al. documented the potential risk for injury in specialized tennis players where in a cohort of 519 elite junior Midwest tennis players (7–18), those who quit all other sports to focus on tennis were more likely to have reported an injury (12). There were limitations with these findings because this was only a cross-sectional association: there was recall and selection bias; specific injuries were not tabulated; there was no control group; and this could not be translated across sports.

A multicenter prospective clinical study evaluating nearly 1,200 young athletes (aged 7–18 years) from a variety of sports by comparing injured athletes was performed. Specialized young athletes were spending greater amounts of time participating in organized sports while participating in less free or recreational play activity. Weekly organized sports hours were nearly double that of free play, and those young athletes who exceeded a 2:1 ratio of weekly hours of organized sports to free play were more likely to have an injury and a serious overuse injury (14). This specialized training resulted in an increased independent risk for overall injuries, overuse injuries,
and particularly serious overuse injuries requiring at least 1 month recovery, even when controlling for age and weekly training volume (14).

**SPORTS TYPE, SPORTS-SPECIALIZED TRAINING, AND SEX DIFFERENCES**

In this large multicenter study, Jayanthi et al. (14) further explored the relationships between sports type (team versus individual), training, and degree of specialization among boys and girls. The authors found that overwhelmingly in this hospital-based cohort, more than 66% of adolescent females were involved in individual sports (e.g., tennis and gymnastics) compared with 61% of adolescent boys who primarily competed in team sports (soccer, basketball, and football). Injury rates were however similar among the females and males participating in either individual or team sports. For example, among team sports participants, approximately 31% of both males and females presented with acute injuries, whereas among individual sports participants, 18% of males and 16% of females presented with acute diagnoses. Despite overall similar injury prevalence rates (73 versus 76%, individual versus team), individual sports participants presented with a greater prevalence of overuse injuries (43 versus 32%, individual versus team, respectively), serious overuse injuries (17 versus 11%, individual versus team, respectively) but almost half of acute injuries (30 versus 17%, team versus individual, respectively).

These data are in contrast to previously reported higher rates of injury prevalence among adolescent females. Schroeder et al. (21) found in a large cohort of high school athletes that adolescent females presented with higher overall injury rates compared with similar-aged adolescent males (1.88 versus 1.26/10,000 exposures). This time, similar to data of Jayanthi et al., individual sports participants presented with the higher prevalence than those of team sports. For example among females, the greatest injury rates were among those in track and field (3.82/10,000 exposures) compared with 1.37/10,000 exposures among the female volleyball players. The study by Schroeder et al. (21), however, is different from that by Jayanthi et al. (14) in finding that adolescent females present with double the prevalence of overuse injuries compared with adolescent males (13 versus 6%, girls versus boys, respectively). The differences may be reflected in that the study by Schroeder et al. did not examine the prevalence of acute or serious overuse injuries nor examine the relationship of sports specialization and sports type. Gender influence on injury risk and injury type may potentially be influenced by the sports type, where adolescent males would more likely be expected to participate in contact/collision sports, whereas adolescent females would be more likely to participate in individual technical sports.

Jayanthi et al. did examine the level of specialization among the different sports types. A greater proportion of team sports participants were categorized as low or moderately specialized compared with individual sports participants (69 versus 55%), while more individual sports participants could be described as highly specialized (45 versus 31%), individual versus team, respectively. In this cohort, moderate and highly specialized athletes were twice as likely to present with a serious overuse injury compared with unspecialized athletes and thus presents as an easily identifiable high-risk group for early sports injury preventive measures.

Age is another factor which seems to moderate the relationship among sports specialization, injury prevalence, and type of sports in which adolescents participate. Similar to previous data (21), injured adolescents are 1.23 times as likely to be older compared with uninjured adolescents (14). This and other recent data further (21,23) support a gender and age effect, whereby there is increased risk of injury with increasing age, and females are generally more likely to experience overuse injuries. Once again these differences highlight high-risk groups, which may be targeted for early sports injury preventive measures.

**OVERUSE INJURY PATTERNS AND THE FEMALE ATHLETE**

Stracciolini et al. (23) examined gender differences for different types of injury and support a gender bias toward greater overuse injuries among female adolescents, using a retrospective chart review in 2,133 children (5–17 years). However, it was also reported that more girls participated in individual-type sports compared with boys who generally participated in more team and contact sports. Among the injured females, 63% reported an overuse injury compared with 37% reporting a traumatic injury, whereas among the males, only 42% presented with an overuse injury compared with 58% presenting with traumatic injuries. Similar to the study by Jayanthi et al. (14), females were more likely to participate in individual sports and subsequently have more overuse injuries. In addition, overall overuse injuries were more common than acute injuries in both studies.

In the study of 1,191 young athletes, acute, overuse, and serious overuse injury types were further investigated using electronic medical records to confirm the diagnosis (14). Of the 837 injuries reported, overuse injuries comprised nearly two-thirds of the injuries, whereas acute injuries were approximately one-third (14). Among the overuse injuries, nearly 25% were serious overuse, which were diagnoses that the treating physician would normally recommend cessation from sport for at least 1 month (14). These types of injuries included bone stress injuries to the lumbar spine or extremities, elbow ligament injuries, osteochondral injuries, and high-risk physeal injuries. Figure 1 presents the frequencies for 3 levels of injury (acute, overuse, and serious overuse) by gender. Similar to the study by Stracciolini et al., girls had fewer acute injuries but significantly more overuse (and serious overuse) injuries compared with boys ($P < 0.012$). Figure 2 adds the degree of sports specialization, that is low = answers one
of 3 sports-specific questions, moderate (mod) = answers 2 of 3 questions, and high = 3 of 3 questions. The frequency of females experiencing more severe sports-related injuries, specifically serious overuse and therefore requiring at least 1-month recovery periods, significantly increased with increasing levels of sports specialization. This relationship was not seen among the males in this sample, who in fact experienced decreasing rates of serious overuse injuries with increasing levels of sports specialization. These studies suggest that highly specialized young female athletes who participate in individual technical sports are more likely to develop more overuse and serious overuse injuries than their male counterparts.

Another study of 546 female high-school soccer, volleyball, and basketball athletes found an association correlation between sports specialization and patellofemoral pain (9). These rates seem to be further increased for other causes of anterior knee pain up to 4-fold (e.g., patellar tendinopathy, apophysitis) for those who reported single-sport participation versus multisport participation. These relationships were not compared with male high-school athletes in similar sports because it was a female athlete study and did not account for exposures. Regardless, increased risk of these overuse conditions in high-school female athletes is consistent with the studies by Straccioli et al. and Jayanthi et al. even in sports that are not primarily or exclusively female. Myer et al. (18) also demonstrated a point prevalence of 16.3 cases of patellofemoral pain per 100 female athletes. The risk for females with patellofemoral pain is even of greater importance because there is some evidence that suggests an increased risk of future ACL injury in these athletes (19).

LEARNING FROM THE WOMEN’S TENNIS ASSOCIATION AGE ELIGIBILITY RULE

Aside from gymnastics, few other sports have been subjected to the scrutiny of early intense specialized training patterns as was women’s professional tennis in the 1980s and early 1990s. There were many emerging “phenoms” on the women’s tennis association (WTA), arriving as early as 13 years, rising quickly in the rankings but experiencing shortened careers, burnout, and significant injuries (e.g., Jennifer Capriati, Andrea Jaeger). In a response to the potentially concerning path for younger players who entered the women’s professional tour, the WTA developed an independent player development medical advisory panel to provide recommendations regarding appropriate age eligibility and premature competition. The result was the adoption of a novel “Age Eligibility Rule” which essentially required a phased in approach to professional tennis tournaments from age 14 to 18 years and also the advent of player development programs geared toward assimilating young players to the challenges of a professional tennis environment. The results at a 10-year review were decreased premature retirements (before the age of 23 years) from 7 to 1% and increase in career longevity (20). This is one of the few longitudinal
assessments of age eligibility interventions in organized and professional sports. The WTA player development model has continued to show objective successes in maintaining careers of its players and may serve as a model for other sports organizations.

**INJURY PREVENTION THROUGH APPROPRIATE COUNSELING**

Through previous evaluations of training patterns of young athletes, and their subsequent injury risks, a potential model for injury prevention through evidence-based recommendations can be developed. Various medical organizations such as the AMSSM (4), AAP Council on Sports Medicine and Fitness (1), and the National Athletic Trainers Association (NATA) (24) have made some recommendations regarding potential risks of overtraining, sports specialization, and preventable overuse injuries. Some of these recommendations include recognizing signs of overtraining, exercising caution with overuse injuries particularly those of higher risk, and discouraging single-sport–specialized training until middle adolescence. Although most organizations generally agree with many of these recommendations, the evidence has not been strong to support them. In addition, there has been little evidence on success of application of injury prevention recommendations (1,4,24) but some evidence to support the lack of compliance with known recommendations such as pitch counts in little league baseball (26).

There are certain recommendations that have been published or have provided some ongoing evidence. As part of an ongoing interventional counseling trial in young athletes, we have certain recommendations of training that may potentially limit injury if adhered to. Some of these recommendations are noted below with Strength of Recommendation Taxonomy (SORT) level of evidence rating:

- Become involved in a regular preseason and/or in-season conditioning and fitness program that also focuses on injury prevention. (24) (SORT A)
- Have at least 1 day off per week from practices, sports-specific training or conditioning, and competitions for organized sports. (24) (SORT C)
- Compete in only one sport during a season at a time. Avoid competing on multiple teams of different sports that would involve more than 5 days per week of participation (practices + competition) (24) (SORT C) (e.g., only doing high-school swimming, not high school swimming + club basketball in the same season).
- Take at least 3 months off (not necessarily in a row) from competing in sports throughout the year. (24) (SORT C)
- Take at least 1 month off from competing in a sport after a season ends. (e.g., If swimming season ends at the end of January, take a month off before competing in baseball during the spring season.) (24) (SORT C)
- Do not specialize in a single sport until middle or late adolescence. (1,4,14,16) (SORT B)
- The total hours of organized sports (training, practicing, competition, etc.) per week should be less than twice the number of hours playing sports just for fun (like playing basketball with friends at recess or after school—“free play”). (14) (SORT B)

(e.g., an athlete who does organized...
societies for 10 hours during the week and has 6 hours of “free play” during the week by playing volleyball at recess and basketball with classmates after school.

- The total hours of organized sports (training, practicing, competition, etc.) per week should be less than or equal to a child’s age in years. (14) (SORT B) (e.g., a 12-year old who participates in soccer [total training, practices, and games] for only 10 hours during a typical week, not more than 12 hours)

- The total hours of organized athletic activity (sports + gym) should be less than 16 hrs/week (including all organized sports-related activities like conditioning/training/practicing/competition). (1,3,4) (SORT B)

CONCLUSIONS

While evidence regarding specialization in adolescent female athletes has generally been lacking, more recent data have emerged. Sports specialization seems to carry risks of burnout and attrition in young athletes. However, more recently, there is evidence to suggest that there is an independent risk of injury related to single-sport training. This risk of injury is further stratified to be increased based on the degree of specialization for overuse and serious overuse injuries.

Adolescent female athletes seem to have a preponderance of overuse injuries. This relationship may be best attributed to the sport selection and subsequent injury types. Higher rates of specialization are generally thought to be seen in technical individual sports such as gymnastics, tennis, and dance. Many of these sports have a high percentage of female athletes. Thus, an at-risk young athlete for overuse and serious overuse injuries would be the one who is female and specializes in an individual technical sport.

Currently, there are few data to support that adhering to training recommendations regarding specialization, multisport play, weekly volume of play, and increasing the proportions of free play would be effective in reduction of injuries and overuse injuries. However, ongoing and future research should be targeted at such risk-reduction strategies in high-risk populations such as the adolescent female athlete.

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REFERENCES


