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Adolescent Sports Injury Prevention and Physiotherapy-Based Exercise

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Abstract. As more and more teenagers begin to participate in these competitive sports and train more frequently, injuries have become increasingly common, making injury prevention a crucial topic. This paper focuses on the prevention of sports injuries in adolescents and the role of physical therapy-based exercise in reducing the risk of injury. It mainly focuses on the common types of injuries in athletes, including ACL injuries, ankle sprains, and overuse injuries, and studies the causes of these injuries. The study findings of this article indicate that injuries are typically caused by a combination of internal and external risk factors. As for internal factors, this includes muscle weakness, poor balance and motor control, previous injuries, and physical changes during adolescent growth. As for external factors, including excessive fatigue load, lack of recovery, poor warm-up, and early specialization in exercise. This article also found that exercise programs based on physical therapy, mainly those involving strength and flexibility training, balance work, and neuromuscular control training, can only help reduce the risk of injury if done regularly (at least once a week or month). These programs are most effective when used as part of normal practice rather than just after injury. The significance of this study suggests that injury prevention should be considered an important component of adolescent sports training, and it is recommended that schools, coaches, therapists, and parents work together to create a safer sports environment for adolescent athletes.

Keywords: Adolescent sports injuries, injury prevention, physiotherapy-based exercise, overuse injuries, adolescent athletes.

1. Introduction

Participation in organized sports has become increasingly prevalent among adolescents, and this trend has persisted consistently over time. A large number of adolescents now join school teams, local sports clubs, specialized training academies and extracurricular competitive programs, with overall participation rates rising sharply in most regions worldwide. This is a highly positive development in multiple respects, as regular sports participation effectively boosts adolescent self-confidence, physical fitness, mental discipline, teamwork abilities and a range of other psychosocial skills. Research also indicates that youth sports participation is strongly linked to sustained physical activity levels in children and teenagers, a critical factor as healthy activity habits established during adolescence frequently shape long-term adult health outcomes. In most cases, adolescents who

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maintain regular physical activity in their teenage years are far more likely to retain active lifestyles in adulthood. For this reason, youth sports extend far beyond competitive victory; they are equally focused on physical health, holistic development and lifelong healthy habit formation [1,2].

Because of the surge in young athletes continuing to engage with sports, leading to a rise in sports injuries in the population among adolescent athletes. They are experiencing frequent and high-intensity training, and also started in specialized sports training at a young age compared to previous generations. Nowadays, adolescent athletes would see scores and compete with school teams and club teams more intensely and simultaneously.

At a teenage age, young athletes cannot take this excessive and cumulative mechanical stress while developing the musculoskeletal system. Training like this simultaneously overly intense and repetitive, can greatly increase injury risk. This is a very crucial concern; this can not only lead to injuries that cause negative performance, but also affect self-confidence and can lead to chronic musculoskeletal issues that continue into adulthood [2-4]. Since the athletes are still not fully physically mature, their muscles and bones are still in a phase to grow and development, so this issue is most urgent for them.

During puberty, bones will go through a longitudinal growth, and their growth plates are vulnerable at the same time, while muscles and tendons will fail to adapt at a synchronized rate. At the time of adolescence, the physical body doesn't always grow evenly. This can affect the coordination and balance temporarily, meaning that young athletes have a higher risk of injury than adult athletes. Some common injuries during adolescence are ACL injuries, ankle sprains, and overuse injuries. Research shows that most of these injuries are caused by movement and physical changes during growth and intense training without proper regulation [3-5].

Injury prevention is crucial. Instead of waiting, more researchers are suggesting adding structured prevention programs during regular training, like physiotherapy-based exercise programs. This can improve flexibility, strength, balance, and movement control to reduce the injury risk, helping athletes to move better for safety and more efficiently. But these programs are not widely used in school sports, and there are only a few programs that are designed for teenagers instead of adult athletes. So this study aims to find how effective physiotherapy-based exercise is in reducing injury risk in adolescents. The study will examine the common injury patterns, risk factors that can change, and injury prevention strategies. Lastly, present a valid injury prevention structure for the young adolescent athletes [6,7]

2. Longitudinal case study methodology for injury surveillance

To better understand how sports injuries occur, it's best to find studies that have followed young athletes for at least a full competitive season. Because these studies can look not only at single injuries, but also at all detailed information of the athletes' main sports, frequency in training, intensity, and recovery habits. Providing a complete and full picture of how the injuries occur and helps identify patterns instead of singular events that should be prevented [3]. The target studies are studies that combine injury tracking with training load data that can present more information for prevention, rather than studies that only record injuries without considering the details, such as the periods of training and the recovery rate [3,4]

A limitation in adolescent injury research is that there is no single definition of a sports injury. Some studies may define an injury just as a missed participation, some may even define it as a condition that needs medical treatment, and some define it as self-reported pain not connected with the training. It is so unclear that it makes it difficult to compare the results from different studies. A full-season study is the most valuable study because it can reflect the real injury pattern in school

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and youth sports settings [3]. For example, a season based long longitudinal study shows that ankle sprains are the most common injury in adolescents. This is important because repeated ankle sprains can indicate that the athlete may have returned to sports too early or hasn't had any proper rehabilitation after the first injury, causing the second and third to continuously increase in risk. This approach helps clearly separate proactive injury prevention from reactive treatment after an injury that has happened for the first time [8,9].

3. Prevalent injury patterns in adolescent athletes

Adolescent sports injuries are widely separated into two groups, where the first is acute traumatic injuries and the second is chronic overuse injuries. Acute injuries happen suddenly in one event, like ankle sprains, muscle strain and ligament tears, etc., while overuse injuries happen more slowly and build up over time due to repetitive mechanical stress without adequate tissue recovery [3,4]. Ankle sprains are a good example of a major injury pattern in young athletes. The ankle takes a lot of stress in sports that involve jumping, sprinting, cutting and landing. This is why ankle sprains are common in badminton, basketball, volleyball, and football. Even though many people think ankle sprains are not too serious, they can still affect performance and dramatically increase the risk of recurrent instability. They may reduce balance, confidence, and stability greatly, and may become a long-term problem [8,9].

ACL injuries are another pattern in sports that involve sudden changes of direction, pivoting, landing and also stopping. These injuries are less common than ankle sprains, but they are often more severe. They usually need long rehabilitation and even surgery. For adolescents, an ACL injury can mean missing a whole season, having future knee problems, and, what most makes athletes scared of, losing confidence. That is why ACL injury prevention has become a major topic in sports medicine and physiotherapy [6].

Overuse injuries are also very important in adolescent sports. These may include shin splints, tendon pain, heel pain, knee pain, and back pain, mainly the lower back. They differ from acute injuries because they don't happen in one specific moment. Instead, these injuries will develop slowly over time when repeated stress accumulates faster than the body can recover. In adolescent athletes, this is a large problem because they may encounter it while their bodies are going through physical changes [4,5,10]. Some injury patterns also may vary from sport. Such as badminton and basketball, ankle sprains are more common because of the times when they land from jumping rapidly. Compared to football, knee injuries are more common because knees and contact happen more frequently during football. This shows that some injury patterns are common in youth sports overall, so it is important to consider the specific sports the adolescent is dealing with.

4. Internal and external risk factors for adolescent sports injuries

Sports injuries are caused by multiple factors that can be grouped into internal and external risk factors. Internal risk factors are things related to the athlete's own body and these include muscle weakness, poor balance, poor flexibility, previous injury and poor movement control. While growth, bones can grow faster than muscles and tendons, which may lead to tightness and temporary loss of coordination. If a teenager already has weak hip muscles, poor trunk stability, or unsafe landing mechanics, a growth spurt may make those problems more obvious and affect future performance greatly [3,4,6]. Previous injury is also a very important internal factor. If an athlete already has an ankle sprain, then the chance of another sprain may become higher unless proper rehabilitation is

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completed fully. The same idea applies to knee injuries and other body parts. Sometimes the athlete feels fine and returns to play, but the ankle is still not fully recovered, working normally [8,9].

External risk factors are more related to training conditions and the sport environment. These include intense training load, poor warm-up, unsafe progression, lack of rest, and pressure to specialize too early. A teenager might play for a school team, a club team, and also do private coaching. Even if each session seems manageable, the total load may become way too much [4,10]. Poor warm-up is also a external factor; if athletes go directly into high-intensity drills without preparing the muscles and joints properly, injury risk increases greatly. Now, limited access to physiotherapy or sports support also matters. If no one is checking movement, fatigue, pain, or recovery, athletes ignore it while the injuries slowly escalate. This is why injury prevention should not be only the athlete's responsibility but also that of coaches, schools, parents, and physiotherapists [4,7].

5. Adolescent growth, excessive training and faulty movement mechanics

A core consideration in adolescent injury prevention is the unique physiological changes of pubertal growth, which uniquely increase injury vulnerability in teenage populations. Adolescent athletes undergo constant physical development, making targeted injury prevention far more complex. An athlete with competent movement mechanics may suddenly develop stiffness and uncoordinated movement; this is not a sign of reduced fitness, but rather the body adapting to rapid musculoskeletal changes [3]. During rapid growth spurts, flexibility decreases and movement timing is disrupted, shifting excessive mechanical stress to vulnerable structures, including the knees, heels, shins and growth plates.

Training loads that suddenly increase may lead to a higher risk of injury. At the same time, physical changes related to growth that are not even noticeable will also greatly increase the risk of injury [3,5]. Too much intense training makes the risk greater because growing athletes need more recovery time when their bodies are still growing. And when there is also not enough rest, the body cannot repair itself normally. Overuse injury is a clear sign that training demand is higher than what the body can safely manage to recover. This shows that rest is not a weakness but a part of crucial healthy training for young athletes [4,10]. Poor movement technique during training and competition is also an important risk factor that can be improved. This includes bad landing technique, bad control of his and ankles, and also a weak core to stabilize when changing direction. For example, if the knees repeatedly collapse when landing, this creates incorrect pressure on the joints, and these small movement problems can become very dangerous in sports because of the speed and force. For injury prevention to be maximally effective, it should not only focus on strength but also on movement quality and correcting unsafe mechanics [4,6].

6. Core components of physiotherapy-based exercise programs

Physiotherapy-based exercise programs are effective due to how they can target not only one injury risk factor but multiple. The goal for this program is to prevent injuries before they even happen, rather than recovering from them afterwards. This program usually includes flexibility training, strength training, and neuromuscular control training, which are all very recommended in sports medicine guidelines [6]. Flexibility training is quite important because growth spurts for adolescents make muscles and tendons rather tight, like the hamstrings and calf muscles, which are the tightest. And when the muscles are tight, movement will be less efficient and joints will take on more stress in all sorts of ways, increasing injury risk. Flexibility training cannot prevent every injury, but it can

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support movement, especially during growth spurts of adolescence [3,5]. Strength training is also quite important, as it focuses on muscles around the hips, knees, ankles and core, which are mentioned. Strong muscles can help absorb force from the joints. For adolescents, strength training should depend on the age and be supervised to ensure safety, but it shouldn't be fully avoided. With supervised and correct strength training, it can help protect teenage athletes from injury [4]. Lastly is neuromuscular control training, this is one of the most important parts of injury prevention programs. It includes exercises like balance/agility drills, single-leg stability, controlled landing, and core stability exercises. The aim is to help athletes keep good stability during movements, not only making their muscles stronger, but also improving overall movement and stability quality [6].

7. Efficacy of physiotherapy-based injury prevention interventions

Research shows that if teenagers regularly do physiotherapy-based exercise programs, it can reduce the risk of injuries. Programs including exercises that help prevent knee injuries like ACL injuries, and warmups that can train how the body moves and control itself, which are neuromuscular warmups. This program can fix poor landing/balance, weak hip muscles, and knees collapsing inward during movement [6]. Athletes who follow this program regularly have a lower injury rate compared to athletes that doesn't follow the program. To maximize the results, it is best to include the exercise in the warmups before the training. If this is done regularly, it will benefit the long-term run, and if not, the benefits will be diminished drastically. For ankle injuries, the best training exercises are balance and neuromuscular training. Those are greatly effect particularly for athletes that had ankle sprains before. These exercises can improve body awareness and stability. But for overuse injuries, prevention doesn't only depend on exercise but also on proper training load, like having enough rest during recovery and starting with a small training load, gradually increasing. This shows that preventing injuries depends on both exercise and how the training and recovery are managed [4,9,10]. Compared to just general fitness training, physiotherapy-based programs are specifically made to prevent injuries rather than build muscles. An athlete may be fit but have movement issues, which lead to injury. Physiotherapy-based programs can correct these issues, supporting both performance short and long term safer in sports [6].

8. A structured and implementable injury prevention framework

The foundation of effective prevention is pre-season musculoskeletal screening, which identifies modifiable risk factors including prior injury, reduced flexibility, impaired balance and movement control deficits. While screening cannot predict every injury, it highlights high-risk athletes who require targeted early support [7]. A structured training component integrates progressive load management, scheduled recovery and a 10–15 minute dedicated prevention segment into every routine practice. A concise warm-up including balance drills, controlled landing practice, strength preparation and dynamic stretching is far more feasible than standalone physiotherapy sessions, with consistency being the most critical factor for success [6].

Multidisciplinary collaboration between coaches and physiotherapists is essential: coaches monitor athletes during daily training, while physiotherapists guide exercise design and risk identification. Shared communication ensures cohesive prevention efforts, with parental support reinforcing load management and recovery habits [7]. Ongoing injury surveillance tracks warning signs through simple, consistent documentation of acute injuries, overuse pain, missed training sessions and recurrent complaints. If multiple athletes develop similar symptoms during high-

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intensity training periods, training load must be adjusted proactively rather than ignoring early warning signs [7].

9. Conclusion

Adolescent sports injury prevention is very important; physiotherapy-based exercise can play a major role for younger athletes to stay safe, preventing injuries in activities and sports. Overall, this paper finds that sports injuries in adolescents are quite common and are usually caused by more than one factor. The main injury patterns discussed in this paper were mainly ACL injuries, followed by ankle sprains, and also overuse injuries, which are quite often in sports with a lot of jumping, sprinting and repetitive training. The research also showed that adolescents are at a higher risk in some ways because their bodies are still growing, and this can affect flexibility, balance, coordination, and movement control. At the same time, external factors like too much training load, not enough recovery, poor warm-up, and early specialization can make the risk even higher. This means injuries in teenage athletes are not just random accidents, but are caused by the body being under too much stress without enough support and control.

Another important result from this paper is that many of these risks can actually be reduced. The studies reviewed suggest that physiotherapy exercise programs, mostly for those that include strength training, balance training, neuromuscular control, and landing technique practice. They can help reduce injury rates in adolescents. The programs work best when done regularly and included in practice sessions; they should be done early instead of after an injury. This is important because injury prevention should be included at the beginning, especially in the warmups. The significance of this paper is to show that injury prevention is connected not only to physical performance but also to mental health. When young athletes are protected from these injuries, they can train more and perform better without worry. It also shows that school, coaches, physiotherapists, parents, and all supervisors have a role in protecting young athletes. However, this study also comes with limitations, where different studies used different definitions of injury, and looked at different sports, including different age groups, which is difficult to compare all of the findings directly together. And not every school has enough access to physiotherapy support and injury prevention programs. In the future, more research should focus on school-based prevention models made specifically for adolescents covering a wider range, and also on ways to make these programs easier in real life for coaches and physiotherapist etc.

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