



Prevention Program in Anterior Cruciate Ligament (ACL) among Indonesian Athletes: A Review Study

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ABSTRACT

An ACL injury has been the most common injury for several years. Athletes and players who play the game have the same risk factor to have it. Injury prevention programs must be conducted among teams and could remove team injury costs in medical staff and rehabilitation. This review aims to conduct one prevention program for ACL injury in Indonesian soccer athletes. In Indonesia, this program needs support from all stakeholders, including the coach,

chief executor manager, and the medical team. The risk factor of ACL injury is divided into external and internal factors, which have to be the main focus of the medical team to process a program. Prevention program for an ACL injury includes strengthening, agility, plyometrics, balance, and proper warm-up. Those types of exercise should be implemented in intervention among athletes, but they still need their perspectives and health condition.

Keywords: ACL injury, athlete, injury prevention, soccer.

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BACKGROUND

For decades, Anterior Cruciate Ligament (ACL) injury has been one of the most common and severe among soccer players.¹ ACL injury negatively affects their team's performance and finance due to their rehabilitation. The prevalence of ACL injury is twice in this second decade; even research and practice focus on its prevention. United States data amount to 200.000 to 250.000 ACL injuries annually, costing \$13,000, or Rupiah currency is Rp 186.979.000.-² Loss of time exists among players, which is the medical team's problem. In this era, much information about the etiology of ACL injury has existed, but the incidence of injury increased in the last decade. The medical team needs a new approach to prevention areas for athletes that lack attention.³

Several studies have found that exercise program for ACL injury is effective, and one of them is strength exercise and plyometric plus balance exercise. Even though the balancing exercise was not focused on control of the proximal knee joint, the effect increases efficiency in preventing ACL injury. The strengthening of the hip and core muscles supports those results.^{2,4} In soccer, there was unsynchronous both in evidence-based practice and in actual intervention used to prevent injury. It will resist the implementation of the ACL injury prevention program.

Regarding the previous study, there are strategies

based on evidence-based medicine (EBM) to prevent ACL injury. Based on the literature, there are significant effects of injury prevention and good exercise, and the most important is the method used. The best one is the method of increasing control in neuromuscular and proprioceptive, in which 51% of the risk of ACL injury was decreased, increased muscle contraction, and increased dynamic stability of lower extremities.⁵

Supported by EBM, ACL injury prevention among soccer player need new approaches, with conducting the risk factor analysis and the association of all of them, and the key to success is an effective intervention. In this study, we will conduct a program on ACL injury prevention with a combination of theory and evidence-based and try to see players' perspectives.^{4,5}

A Consideration In Building an ACL Injury Prevention For Indonesian Soccer Players. What Causes ACL injury? The Analysis of Risk Factors and Program Planning

In ACL injury prevention, one needs to know what causes that injury and how the injury is. That will be applied in intervention and may develop a promising target in the risk factor. A quarter of injury was developed from their history below 18 years old. The prevalence of ACL injury is more dominant among males than females, which implies that soccer players are mostly male. The risk of an ACL injury was 2-8 times higher in females

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than in males.² An ACL injury prevention program must focus on biomechanics, psychological, socio-economic, and intervention effectiveness.⁶ Internal and external factors existed (Table 1), but the issue of biomechanics is one of the main focuses. Some studies found that age, gender, and type of sports are risk factors for ACL injury.^{2,6}

The primary function of the quadriceps was supported by anterior force and extension knee. Overload of quadriceps muscle could increase anterior translation of the tibia and force in the tibiofemoral joint, increasing the risk of tearing ACL. Knee flexion at 30-90 degrees was the position when the quadriceps contracted eccentrically and resisted the weight. The ligament was in elongation, posterior translation of the tibia, and quadriceps acted in knee stability in that position. Valgus position existed while quadriceps cannot afford on the knee. On the other hand, an ACL injury is also influenced by weakness of the eccentric hamstring muscle on balancing quadriceps in a semi-flexion position, and it made compensation for hamstring limited knee range of motion, lack of muscle stretch, and muscle contractility. Axial force on the tibiofemoral joint could increase compression and transition non-weight bearing (NWB) to Weight bearing (WB) in internal torque and affect anterior tibial translation. The hip, knee, ankle, and foot helped balance compression during anterior tibial translation. When this segment is ineffective in distributing weight or overpronation inflicts buckling knee position and increases ACL injury risk.⁷

Knee extension and hip flexion position made more significant angle will influence change of angle tibia and femur based on tilted of tibialis posterior. The change of anterior tibial translation increased the risk of an ACL tear. Landing on valgus position or knee abduction might increase axial force and friction of 2-degree valgus decreased ACL ligament compression. A valgus position has more axial force on the lateral side of the knee than on the medial side. It would more axially force on the lateral side with wider internal rotation. In the knee abduction position, the lateral side of the knee relaxed, and the other side meanwhile contracted with a combination of the medial compartment was limited. The lateral compartment strengthened and challenged the intercondylar of the lateral tibial slightly anterior and internally rotated to the medial side, increasing the risk of injury.⁷

According to Piero, Volpi et al. (2006), an ACL injury during a soccer game majority among defenders due to their ball tackle technique on hip rotation and adduction position and the high risk of tearing a ligament. Professional players have

a higher risk of getting ACL injury, and they are supposed in high skill and have to be in the best performance game. At the same time they dribble, an athlete uses one of their dominant extremities and has more risk of injury. Games held on synthetic grass ground resulted in more hazards than the natural ground because it affected their shoes and indirectly affected them to a higher risk of injury.⁶

Several studies showed that young adult soccer players over 18 years old and female gender have a higher incidence of injury. In Soccer players, especially professional athletes older than 18 years old, women's risk factor is 2:1 more than males develop ACL injuries because of physiology on hip and q-angle related factors on knee abduction position.⁶ The effectiveness of exercise on the proximal area was significant in preventing an injury. Explained physiology reason, the rigid landing could create more considerable force followed by hip and knee flexion; this biomechanics process would help increase muscle strength and protect ligaments. Focused exercise on the sagittal plane could decrease knee abduction with its impact on injury.² Knowledge of movement risk factors in ACL injury was needed, especially among athletes, to get the biomechanics process of it, and the development of their brain activity implicitly will affect their games and control of motoric activity. Input to Motoric cortex activity increased "action" automatically changes their movement, especially during games. This practical solution for athletes was exercise, focus, and awareness of their movement is the key to preventing injury.²

Supports from Stakeholder

Successful preparation and action in real soccer games need more support, especially from those involved, including coaches, athletes, and even chief executive officers. Coach played essential roles in each game within their strategy; they need to know about injury prevention and control. The medical teams must do their best to fulfill the manager and coach's expectations.¹ Another component team in charge of injury prevention strategy must be aware of new knowledge and communication. Athletes' trust during the whole program was an absolute key to preventing an injury and upgrading their performance in the game.⁸ Communication between the coach, management, and medical team was the most important during the program. They believe the medical team and program will positively affect their athletes' performance and reduce injury costs. Therefore, how the medical team convinced all stakeholders was the second critical success factor in the ACL injury prevention

Table 1. Specific and General Risk Factors of an ACL Injury.

Specific Risk Factor	General Risk Factor
Weakness of quadriceps and hamstring ⁷	Age ⁶
Position ⁶	Gender ⁶
Hamstring compensation ⁷	Dominant extremity ⁶
Whole body dynamics ⁷	experience ⁶
ACL injury history ⁶	Surface of yard ⁶
	Shoes ⁶
	Exercise' and competition effect ⁶

program.⁹ Basic principles among medical teams and professionals involved in their context and open discussion with good communication will increase the challenge of a suitable prevention program for each individual.¹

Intervention Target For Athletes

An ACL injury prevention program showed significant results in fit targets with different hazards for each individual. Soccer players must pay attention to their health evaluation or health screening, which must be done before each game. If a hazard is found, an increase in awareness is needed. Give an example, if found quadriceps muscle weakness, the next step is supposed to be a proper exercise to strengthen muscles. This data validation could be coach evaluation during exercise and game, and hazards could be prevented due to awareness of their specific condition.¹⁰

Implementation of the ACL Injury Prevention Program

An ACL injury prevention program was crucial to implement in most sports teams. ACL injury was the most common injury among soccer players, with a prevalence of 60% returning to the game after five years of ACL injury.¹¹ Although ACL injury prevalence in Europe has decreased since 2000, but not significantly decreased with external factors. That's why this program is needed and critical to all stakeholders.

The purpose of ACL injury prevention needs first risk factor identification with all players done their health screening. Health assessment is the term for early diagnosis or mention of a hazard among them. Afterward, they could focus on improving performance in the rehabilitation field. Athletes with hamstring tightness will have an exercise purpose, like stretching or releasing muscle 7-10 seconds within 30 seconds of resistance and then back to a neutral position in 8-10 seconds. Early protection and early diagnosis were other key factors in prevention programs.¹²

Five Points ACL Injury Prevention Program Among Indonesian Athletes

Strengthening Exercise

The Quadriceps muscle was an essential part of the body while running, jumping, landing, and sudden movement maneuvers. Overloading quadriceps muscle and uncontrolled affected anterior tibial translation and is a risk factors for an ACL tear. An imbalance of quadriceps and hamstring muscle exercise effect muscle activation and reduces the stability of the knee joint, develop of anterior tibial translation on response dominantly quadriceps muscle. Therefore, exercise must be decided based on experience influenced by the best knowledge; one good exercise is hamstring to the quadriceps muscle. This was good for the support function of the ligament on its role in the stability of the knee joint and distributed weight on articular surfaces. Trunk and core muscles also play a role important during body movement. Its function in controlling the center of body mass needs good preparation, and its key to success must be exercised. Besides extremity exercises, core and trunk exercises are also required for injury prevention programs.³

The majority of ACL injury influenced by a lack of hamstring support as an active stabilator on the landing mechanism. A combination of trunk, knee and hip minimal flexion position resulted in changes in knee position while landing. Knee movement to a frontal plane called valgus position or knocked kneed position increased stress on the ligament.¹³ In the ACL injury prevention program, an effective intervention was needed to change those mechanisms. One effective exercise strengthened the eccentric muscle contraction hamstring that would respond to lessen the landing mechanism during the terminal swing phase and protect from an overload of the ligament.¹⁴

The one mechanism from the body's physiology that could protect the ACL was the eccentricity of the hamstring. Full extension limited its mechanism, and eccentricity of the hamstring has contributed to preventing anterior tibial translation. It's measured using an isokinetic dynamometer (seated) or measuring the jump.¹⁵

In strengthening the program, factors that probably included:

- a. Strength of extensor hip, flexor hip, and external rotator hip. This is an essential part of preventing ACL injury due to the mechanism of an ACL tear, the internal rotation of the hip, hip adduction, and knee abduction. Significant hamstring activation could reduce vertical changes in

the body and balance forces on both knees.¹⁶ Increasing eccentric hamstring, quadriceps, and external rotator are given by deep squat exercise. It's contracted eccentric quadriceps, and it will reduce the force on the tibiofemoral joint.¹⁶

- b. Biomechanics. Soccer players use the cutting technique in flexion of the hip minimally in the sagittal plane, and this is based on a program that reduces abduction knee and will adapt it.¹⁷
- c. The stressor of the knee. A close kinetic chain (CKC) was recommended to improve muscle strength on the lower extremities and reduce anterior-posterior tibialis. This exercise has a concept of resisting force on the lower extremity and will affect the knee joint's articular and decrease the anteroposterior tibial on the femur. CKC is more effective in improving the arthrokinematics of the knee than the open kinetic chain (OKC).¹⁶ Kind of exercises that included strengthening due to the ACL prevention program were: leg press, double-legged squat, single-legged, squad, forward lunge, prone lift, heel raise, lateral lunge, diagonal lunge, abdominal curl up, prone plank, side plank, back extensor, hip bridge, pull over.³

Agility Training

Soccer games need basic skills: dribbling, passing, controlling, stopping, shooting, cutting the ball, and keeping. They must be good at everything, especially those who have been athletes, and for that reason, the essential skill was dribble.¹⁸ Most common ACL injury was from both direct or direct contact. An ACL injury prevention program would be successful if all the exercise programs included the neuromuscular and biomechanics of the lower extremities. A Multicomponent or combination of programs (e.g., a combination of agility, balance, and flexibility exercise) had been more effective than focusing on an exercise. According to the literature, the exercise recommended for prevention programs was agility.³

Agility and sprinting were two combinations of exercise needed in soccer regarding their function on neuromuscular control and biomechanics of the lower extremity. Quality is necessary, and its movement in soccer was crucial to agility, dribble, and ball control.¹⁹ Motoric in charge of controlling movement also plays an essential play in the body; if their coordination isn't established, it will affect biomechanics.²⁰

Agility is essential in soccer, and an athlete must have it. Agility has an association both physical and cognitive; it's affected by balance, coordination, the center of gravity, speed, and run capacity. Examples of its exercises were: Linear sprinting: 20m, 30m,

40m, and 50m, manual stopwatch; Speed of reaction + speed off the mark 5m, 10m - 15m; agility: 25m changes of direction each 2.5 m; Speed-endurance - 4 x 10m with the change of direction (shuttle running); Speed-endurance + coordination.¹⁹

Plyometrics Exercise

Plyometrics exercise is one crucial component, especially in group team sports. This exercise was also approved as a safe and effective method to improve exclusivities among team members.³ It combined increased neuromuscular function and bone density simultaneously; the other side also affected psychological, cardiovascular, and body weight and prevented injury. One cause of an ACL injury was direct contact, valgus extremities movement, and abduction knee with adduction torsion of the hip on jumping.²¹ This exercise will help reduce it, including dynamic and fast, jumping, landing, and bouncing. The focus concept was a fast and repeated transition from extension muscle to contraction.

The plyometric exercise combines both speed and strength, and it uses eccentric contraction of the muscle and then eccentric contraction; this process is called the stretch-shortening cycle (SSC). SSC could improve muscle unit on maximum strength while minimizing movement valgus and focusing on jumping. Landing mechanism in this exercise, an athlete has to decrease their valgus movement, keep balancing the knee, slowly increase speed, and all those exercise intensities increase with compound another complex movement and add some landing movement to finish it.²² An example exercise of plyometric that charge prevents ACL injury were Ankle bounce, Squat jump, Scissor jump, Stationary single-legged hop, Forward-backward line/cone jump and hop (double-legged and single-legged, Sideways line/cone jumps and hops (double-legged and single-legged), Bounding, Diagonal bounding, Side-to-side bounding, Box jump.³ Those types of exercise are effective among soccer players, especially in gaining fitness.²³

Balance Training

The definition of balance was the body's position on the kept center of gravity in the base of support divided by static and dynamic balance. Static balance supports the body in a static position; meanwhile, dynamic balance supports transition or movement.²⁴ Component of balance were visual input, vestibular, and proprioceptive. Balance and proprioceptive were neurologic processes for controlling the body on its position.²⁵ Balance and coordination were two parts important in activity life, including sports activity. The aim of balance

training at first was to gain a proprioceptive and control brain to be aware body's position. The most common component of balance training was proprioceptive.⁵ Therefore, it's common also during rehabilitation progress and competition training; it will help a lot which means it will prevent further injury.²⁵

According to a study from Allesandro, balance training with a control method on proprioceptive could prevent 51% of ACL injuries and improve stability in the lower extremities. On stability, the knee valgus and varus need balancing of the quadriceps and hamstring muscles. If both muscles are in good balance, it affects the adduction of the knee. Several studies also proved that balance training positively prevented an ACL injury due to neuromuscular and proprioceptive reasons.^{2,26,27} Balance training on prevention of ACL injury program were; single leg standing, single leg balance with upper body movement, single leg balance on an unstable surface, single leg balance with lower body motion, squat jump with stabilization, and another exercise based on individual condition and capability.³

Warming Up

Warming up has been recommended by experts, researchers, and medical teams and is the most important thing in sports. It's been a role and essential thing before starting the sport. The aim of warming up, known as improving or increasing muscle stretch, would prevent muscles on dangerous and prepare them for the main part of sports. A proper warming up before doing activities or sports will increase muscle temperature and its effect on the internal or biological change of muscular cells, vasodilate of the blood vessel, and optimized metabolic response.²⁸ Responses of contractility in cells will change resist muscle, increase strength and stretch and have a substantial psychological impact. Good warming up must design well for each individual, and control of its intensity depend on their capability and capacity. An excellent example of good warming up is an athlete's capacity as a primary player must have different qualities of warming up with who is the critical player or most valuable player (MVP).²⁹

According to FIFA 11+, it was warming up extensively with six exercises, including jogging and three other aerobic exercises that purpose on cardiovascular in the end. All six exercises aim at the prevention and focus on stretch, lower extremity muscle, balance, agility, and three other exercises progressively focus on each exercise balancing the center of the body and extremities in 20-25 minutes, and the program is finished.³⁰

CONCLUSION

An ACL injury was the most common knee injury and was affected by external and internal risk factors. Biomechanics factor, the one has to focus on the program regarding reason uncontrolled of it. All stakeholders, including coaches, chief executive offices, and athletes, have their role in programs due to their success, and a whole program needs collaboration. A prevention program known for each individual focuses on their biomechanics and mechanism of injury. The crucial role in the exercise program was the type, volume, and intensity. In this article, we conduct basic exercises and try to design an effective program which is a multi-component program. It included strengthening, agility, plyometrics, balance, and warm-up exercises. That program was chosen regarding EBM and is supposed to develop among athletes to prevent injury. Optimizing principles of motoric and neuromuscular control physiologically would improve their capability and quality and decrease the risk factor of an injury.

CONFLICT OF INTEREST

No conflict of interest in this review.

AUTHOR CONTRIBUTION

MVPG, IDMAS, KTBS, and DGM wrote the article, searched the literature, and revised the article; NKYF wrote and revised the article; IPGSA conceived the study design, searched the literature, and revised the article.

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