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ANALYSIS OF MAXIMUM SQUAT ABILITY IN FUTSAL PLAYERS WHO HAVE A HISTORY OF LEG INJURIES

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Abstract. A person's maximum squatting ability can be known using biomechanical analysis. Biomechanical analysis is also a form of injury prevention. For futsal players, squats are one of the exercises used to determine the strength of the leg muscles. The aim of this study was to analyze the maximum squatting ability of futsal players who have a history of leg injuries. This research uses quantitative descriptive research by analyzing kinematic principles in biomechanics using kinovea 0.9.5 software. A purposive sampling technique was used in this research to determine the research sample, which consisted of 9 male athletes with a history of leg injuries. The results obtained in this study in the eccentric phase of the squat movement resulted in an average body tilt angle of 63.16 ± 9.58 degrees and a knee angle of 49.1 ± 10.61 degrees. The tilt angle of a normal person's body position during a deep squat or maximum squat position is 52.6 degrees. The knee angle during the maximum squat movement is 120-140 degrees and the squat position at full depth is 115-125 degrees. The limitation of this research is that the motion analysis was not carried out in 3 dimensions, so horizontal and frontal motion could not be analyzed.

Keywords: motion analysis; maximum squat; injury prevention; futsal

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INTRODUCTION

Starting from children to adults, Indonesian people like the sport of futsal. The futsal game is played by 5 people from each team with a very fast and dynamic game tempo (Narlan et al., 2017). The very fast and dynamic tempo of the futsal game has an impact on futsal players who are required to always move and require good technical skills and high determination (Syafaruddin, 2018). The impact in futsal is that there are sudden movements or sudden stops and often collisions between players which can cause injuries to futsal players. Injuries to the legs can be one of the main challenges faced by futsal players, because the game of futsal relies heavily on the legs as the main support in playing futsal.

According to Matias (2012), there are several types of injuries suffered by futsal players in the legs, including: hamstring, ACL (Anterior Criciate Ligament), Meniscus, Patella Tendinitis, Plantar Fascitis, and Ankle. Leg injuries in futsat players can cause significant pain, reduce the player's mobility, and can limit movement in daily activities. Leg injuries in futsal players can not only hamper current performance, but also have the potential to have a long-term impact on physical abilities.

Good management is needed so that leg injuries that occur in futsal players do not become too serious for the players and that they can reap achievements. Injury prevention can be done through training programs to strengthen players' muscles. Squats are considered to be an effective type of exercise in increasing the ability and strength of the lower leg muscles (Rachman, 2021). Squat exercises can be used by futsal players to help reduce and prevent leg injuries and can improve performance because they involve several muscle groups such as the quadriceps, hamstrings and gluteus maximus (Mansur et al., 2018).

According to research by Zawadka et al., (2020) in their research entitled "How Are Squat Timing and Kinematics in The Sagittal Plane Related to Squat Depth?" which analyzes the relationship between Range of Motion (ROM) in the sagittal plane and time parameters during maximal squatting. This research showed that Range of Motion (ROM) at the knee provided the most significant contribution of all joint ROM to determine the maximum squat position.

This research also states that mobility or movement of the hip and ankle joints is important when performing squat movements because it functions to maintain body balance during the squat position. Research by Butler et al., (2010) states that deep squats can be a screening tool used to show differences in mechanics when assessing a person's functional abilities. This is stated in the results of research on individuals with different squat movement values and conditions as determined by the Functional Movement Screen (FMS), showing differences in a person's mechanical abilities or functional abilities.

A person's maximum squatting ability can be determined using biomechanical analysis. Biomechanical analysis is also a form of injury prevention. Biomechanical analysis is used to determine whether the movements performed are in accordance with the appropriate technique or not in order to perfect the movements performed. Biomechanical analysis is used to prevent injuries in athletes. Athletes will be given recommendations related to the results of biomechanical analysis so they can carry out effective and efficient movements (Irawan & Long-Ren, 2015). Analysis of maximum squat ability in futsal players who have a history of leg injuries is an important aspect of understanding the impact of injury on core and leg muscle strength. Squats as an exercise that involves a large number of muscles, including the thigh, hip and back muscles, are a relevant indicator in evaluating the strength of these muscles.

The urgency of this research is to analyze the maximum squatting ability of futsal players with a history of leg injuries. Through this analysis, we can identify how far recovery has progressed, whether there is a strength imbalance between the injured and non-injured limbs, and how recovery can be improved. It is hoped that this research will provide deeper insight into the physical condition of futsal players who have experienced leg injuries. Additionally, this information can serve as a basis for the development of more effective rehabilitation programs and injury prevention in the future. By understanding the relationship between injury history and squatting ability, medical teams and futsal coaches can design a more targeted approach to improving a player's performance and health, as well as minimizing the risk of

injury that could interfere with their contribution to the game.

METHOD

The method applied in this research is descriptive analytic with a design using a one-shot case study, namely an experiment carried out without a comparison group and without an initial test. The analytical descriptive approach specifically examines movement analysis to provide explanations related to distance, body segments, time, and speed in performing squats (Soendari, 2012). Data collection techniques involve observation methods, measurement tests, evaluation, and video documentation using a camera. The data was then analyzed using Kinovea version 0.9.5 software to obtain information such as stride length, time, and movement angle.

This study used a sample of 9 male athletes with a history of leg injuries. A Purposive sampling technique was used for sampling with sample selection based on certain criteria and considerations that had been determined by the researchers, namely male futsal athletes who had a history of leg injuries to be tested by doing squat movements.

This research was carried out at Gor Wujil Ungaran with test participants given instructions before carrying out the test and doing sufficient warm-up. The research steps carried out include (1) preparing writing equipment to record test participant data, a tripod, and using a camera to record the squat movement, (2) placing the camera perpendicular to the sample and starting recording when the sample performs the squat movement, (3) research participants were directed to perform squat movements with their knees positioned at a maximum of 90 degrees (parallel to their hips). After all processes are complete, the best data will be analyzed by researchers using research instruments, namely the Kinovea application version 0.9.5, to obtain analysis results in the form of step length, time, and movement angle.

RESULT AND DISCUSSION

The results of this research obtained sample data with a total of 9 Young Captain Futsal Academy players consisting of age, height, weight, and BMI (Body Mass Index). The following are the results of the anthropometric data of the Futsal Academy Young Captain futsal players.

Table 1.

Player Anthropometric Data

Category	Mean ± SD	Min	Max

Height (meter)	1,71 ± 0,05	1,61	1,78
Weight (kilogram)	64,77 ± 13,45	52	95
BMI (kg/m²)	21,84 ±3,67	18,1	30,06

Information: Research 2023

Based on table 1 data, the anthropometric results of the Futsal Academy Young Captain futsal players who have a history of leg injuries have a sample height of an average of 1.71 m, a maximum height of 1.78m and a minimum height of 1.61 m which has a standard deviation ± 0.05 m. The sample body weight had an average of 64.77 kg with the largest body weight being 95 kg and the smallest body weight being 52 kg with a standard deviation of ± 13.45 kg. The sample's BMI (Body Mass Index) has an average of 21.84 (kg/m²) with a maximum sample BMI of 30.06 (kg/m²) and a minimum BMI of 18.1 (kg/m²) which has a standard deviation value of ± 3.67 (kg/m²).

Results of analysis of the squat movements of Young Captain Futsal Academy players with a history of leg injuries consisting of an eccentric phase (descending phase) and a concentric phase (standing). The results of the squat movement analysis data are presented in table 2 which includes the following data.

Table 2

Squat Movement Analysis Data

N=9	**Mean ± SD**	**Min**	**Max**
Time (s)	2,08 ± 0,26	1,8	2,64
Stride Leg (cm)	6,54 ± 0,93	5,32	8,6
Eccentric Phase			
Eccentric Phase Time *(s)*	1,06 ± 0,12	0,9	1,3
Body Tilt Angle (°)	63,16 ± 9,58	44,9	74,8
Hip Angle (°)	61,35 ± 7,46	47,2	70,6
Knee Angle (°)	49,1 ± 10,61	30	64,1
Ankle Angle (°)	54,2 ± 6,71	44,1	63,7
Concentric Phase			
Concentric Phase Time (s)	1,02 ± 0,14	0,83	1,33

Information: Research 2023

In table 2, the results of squat movement analysis using kinnovea 0.9.5 software on 9 Young Captain Futsal Academy players who had a history of leg injuries, using several indicators such as leg distance (cm), spine tilt angle (°), hip angle (°), knee angle (°), ankle

angle (°). From the results of the squat movement analysis data, it can be seen that the average time during the squat movement was 2.08 ± 0.26 seconds, with a minimum time of 1.8 seconds and a maximum time of 2.64 seconds. During the eccentric phase, the average time obtained was 1.06 ± 0.12 seconds, with a minimum time of 0.9 seconds and a maximum time of 1.3 seconds. Meanwhile, the average time obtained for the concentric phase was 1.02 ± 0.14 seconds, with a minimum time obtained of 0.83 seconds and a maximum time of 1.33 seconds. In the eccentric phase of the squat movement, an average spine angle of 63.16 ± 9.58 degrees, hip angle of 61.35 ± 7.46 degrees, knee angle of 49.1 ± 10.61 degrees, and ankle angle of 54.2 ± 6.71 degrees.

In performing a maximum squat movement or in a full depth position, good mobility of the knee joints and hip joints is required. Analysis of maximum squat ability is needed for players who have a history of leg injuries to determine movement ability and joint mobility (Range of Motion). When doing squats, the position of the body tilt is one of the things you need to pay attention to. This is because the tilt of the body position during the squat movement is one of the factors determining whether the body position leans forward or backward and provides a greater contribution from the back muscles.

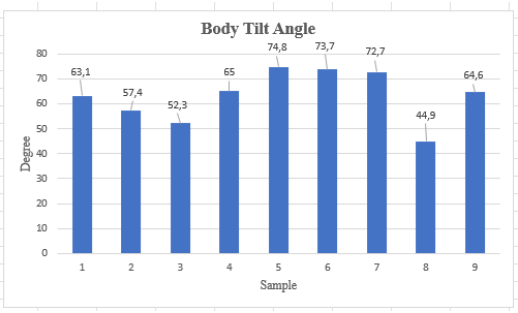

Figure 1. Eccentric Phase Body Tilt Angle

In the sample, young futsal academy captain players who had a history of leg injuries had an average body tilt angle in the eccentric phase during deep squats, namely 63.16 ± 9.58 degrees. According to (Horschig, 2020) the angle of inclination of the body position in normal people during a deep squat or maximum squat position is 52.6 degrees. If you look at Figure 1 which shows the graph of the angle of inclination of the maximum squat body position carried out by 9 samples, the result is that 2 samples are close to the ideal angle during the deep squat movement.

This indicates that the sample of futsal athletes at the Young Captain Futsal Academy club have not performed the eccentric phase when the

squat position is optimal. The tilt of the spine so that it leans forward will provide a greater contribution from strong back muscles. The tilt and balance of the body are also influenced by the strength of the leg muscles themselves, especially the knee and ankle muscles. Generally, the ability of the squat movement will produce an angle from each part of the body that becomes part of the contraction when performing the squat movement.

The ability and flexibility of the knees are also used as body support which affects the balance and tilt of the body when doing squats. According to research by Schoenfeld (2010), the knee, especially the ACL (Anterior Cruciate Ligament) is often used as the most important joint stabilizer. The primary role of this knee during the squat is to prevent anterior tibial translation of the knee angle, especially at low flexion angles. It also plays a role in limiting internal and external rotation of the knee and may inhibit varus or valgus movements. individuals with knee pain may be better suited to limiting their range of motion to a more "functional" range of 50° of knee flexion if specific to their sport. The knees should not go past the toes or move forward, which will cause the body to lean forward, making the squat less than optimal.

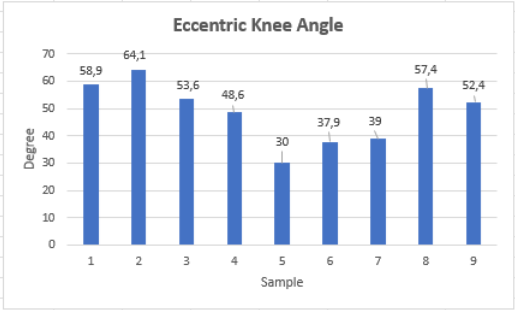

Figure 2. Eccentric Knee Angle

In cases of other injuries, such as knee injuries, there is also a relationship which states that in cases of knee injuries, the Range of Motion (ROM) of the knee makes a significant contribution from all joints related to maximum ability when performing squat movements (Zawadka et al., 2020). The results of the analysis stated that in the 9 samples of Young Captain Futsal Academy athletes, the knee flexion angle that reached the maximum angle of the squat movement was 64.1 degrees. According to Daniel Richter (2023), maximum knee flexion during the squat movement is 120-140 degrees, which will cause greater muscle growth in the quadriceps and gluteus. In research (Endo et al., 2020), the maximum knee flexion angle for the squat movement was 124 degrees, it was stated that the knee flexion Range of Motion (ROM) was significant and had a positive value correlated with the ankle

dorsiflexion angle, knee flexion angle and hip flexion angle. The knee flexion angle of less than 120 degrees following previous research, which shows that young Captain Futsal Academy athletes who have a history of leg injuries still experience pain so that there is limited movement and muscle weakness which results in the ability to perform squat movements not being able to reach maximum squat movement.

According to research by Comfort & Kasim (2007), the optimal squat technique ensures a wide leg stance in a shoulder-width position, the knee movement is not further forward than the toes, the gaze is in a forward position (not downwards), and at a full depth of 115-125 degrees. Squat depth is one of the variables used to assess whether the squat movement performed is optimal or not (Bryanton et al., 2012). To prevent injury, it is necessary to carry out an exercise or movement program that is used for the rehabilitation process or to increase the strength of the lower leg muscles, especially the hamstring muscles. Squat training is a type of weight training that is used to increase the strength of the leg muscles and weight training is the main basic training (Rachman, 2021). The squat movement can be an option to reduce the risk of hamstring injury. According to previous research (Diggin et al., 2011), the results showed that the front squat movement would provide the smallest risk of injury to the lower back and knee joints. The squat movement can also provide the same ability to strengthen the knee extensors as the back squat movement. Front squats can also allow players to maintain a more upright posture.

CONCLUSION

This research concluded that the Young Captain Futsal Academy players with a history of leg injuries were not able to perform squat movements optimally. Thus, the leg muscle ability in players with a history of leg injuries is less than optimal when playing. Athletes need to rest and exercise regularly so they can perform squat movements optimally to improve leg muscle ability after injury.

The results of the analysis showed that the body tilt angle was 63.16 ± 9.58 degrees and the knee angle was 49.1 ± 10.61 degrees. The results of the analysis are used to understand the impact of injury on leg muscle strength and can identify the extent of recovery. A limitation of this research is that

motion analysis was not carried out in 3 dimensions, so horizontal and frontal motion could not be analyzed. The hope of future research is to be able to measure the Range of Motion in squats, either 90 degrees or deep squats.

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