SQUAT JUMP GOAL KEEPER AND FIELD PLAYER BIOMECHANICS ANALYSIS

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Abstract

Leg muscle power supports the motor action of playing futsal for both the goalkeeper and field player. The squat jump is one of the tests for lower-body strength. The research purpose was analyzed the difference in squat jump performance between goalkeeper and field futsal players. The research sample consisted of 12 male futsal athletes (mean 19.50 ± 0.52 years, 59.17 ± 7.30 kg, and 166.17 ± 5.64 cm). Independent t test was used to determine the difference in jump height between the two playing positions. Multiple linear regression test was used to show the contribution of the kinematics parameters and squat jump kinetics to the squat jump height. The results showed that the squat jump performance was 49.00 ± 1.55 cm for the goalkeeper and 46.33 ± 1.37 cm for the field player. Independent t test shown a significant difference in the jump height of the two playing positions with a jump height difference of 2.67 cm higher for the goalkeeper (p-value = 0.01). Multiple linear regression test showed that the kinetic parameters, namely power, work, and force contributed 97.7% to the difference in jump height in the two playing positions. So it can be concluded that to produce a high jump requires power, work, and force.

Keywords: Squat jump. Goal keeper. Field player. Biomechanics.

Introduction

The key to futsal performance is having power and strength ability. These abilities play a role in acceleration and deceleration tasks, high jumps, and change of direction [1]. When athletes carry out competitive sports, lower extremity injuries can occur so athletes need to increase their lower extremity muscle strength. The analysis results of the incidence and characteristics of the futsal team's injuries showed that 85.2% of injuries occurred in the lower extremities, i.e. the ankles with a percentage of 40.7% [2]. Therefore, to avoid lower extremity injuries, Kockum and Annette [3] (2015) suggest using dynamic muscle strength tests to evaluate muscle function and strength, especially lower extremity muscles. The importance of evaluating the ability of lower extremity muscles is due to the role of these muscles in generating high strength and speed during sports performance [3].

Lower extremity muscle strength tests can use the squat jump. Konckum and Annette [3] explain that the squat jump is designed to improve athletic performance, therefore it is considered the highest test of lower-body strength. Dynamic control of the knee can be increased through squats, this is due to the involvement of the simultaneous activation of the hamstring and quadriceps muscles. The involvement of the activation of these two muscles plays a role in preventing knee injuries. Meanwhile, according to Davies et al [4], squat jumps can be a reference to increase power to its best peak, improve muscle performance, increase acceleration, and improve neuromuscular coordination by training the nervous system. So in the implementation of the squat jump movement must be considered carefully to get maximum results.

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In the game of futsal there are playing positions, namely the goalkeeper and the field player. Leg muscle power supports the motor action of playing futsal for both goalkeepers and field players [5]. Leg muscle power is needed by the goalkeeper when jumping to catch the ball that soars towards the goal, while the field player when taking action controls the ball quickly and sprints high. Both have different jump heights. Stølen et al [6] in a review showed that goalkeepers have the highest jump scores of other field players in the vertical jump test. To get a broad understanding of the determinants of the difference in jump height in the two playing positions, it is necessary to study biomechanics. The findings of this study can be practically applied to improve the development of poor squat jumps to good ones, so it is important to know the variables that contribute to squat jump performance. Therefore, the research purpose was analyze the difference in squat jump performance between goalkeeper and field of futsal players.

Method

The 12 male futsal athletes aged 19.50 ± 0.52 years, weight 59.17 ± 7.30 kg, height 166.17 ± 5.64 cm, actively involved in futsal for > 3 years, and not having leg injuries (6 goalkeepers and 6 field players) (Table 1).

Researchers used a cinematographic method that records a movement [7]. This approach aims to explain the squat jump performance which includes jump start, take off, and top of jump [8].

Before undergoing the squat jump test, the sample warmed up for 5 minutes. The squat jump test was carried out 3 times using arm movements. Participants are advised to bend their legs to produce a high jump [9]. The best jumps are taken for analysis using dartfish software. The Canon EOS 1100D DSLR camera was placed around the data collection area to record the kinematics of the squat jump motion, recorded at a frequency speed of 700 Hz. The placement of the camera is in two positions. Camera 1 is mounted 1 meter on the right side of the participant and is perpendicular. Camera 1 aims to capture body movements in the side plane, while doing squat jumps. Camera 2 is behind the subject to capture movement from the back plane, while performing a squat jump.

Table 1: Characteristics of Sample.

Position	Age (year)	Height (cm)	Weight (kg)
Goalkeeper	19.33 ± 0.52	167.00 ± 5.29	58.17 ± 5.78
Field player	19.67 ± 0.52	165.83 ± 5.95	60.17 ± 9.02

Basic descriptive statistics, namely mean and SD, are used to explain body kinematics which is divided into squat jump and body kinetics stages. Independent t test is used to determine the difference in jump height between the two playing positions. Multiple linear regression test was used to show the contribution of the kinematics parameters and squat jump kinetics to the squat jump height. Multiple linear regression test was performed using SPSS 17.0.

Result and Discussion

Table 2 shown that there is a statistically significant difference in jump height between goalkeepers and field players with a jump height difference of 2.67 cm higher for goalkeepers (Table 2).

Based on the jump height, the stages of jump start, take off, and top of jump do not contribute to the difference in squat jump height between the two playing positions. Meanwhile, the resulting power, work, and force contribute to the difference in the height of the squat jump between the two playing positions. This height variation is influenced by kinetic parameters (power, work, and force) of 97.7% (Table 3).

The series of squat jump movements, starting from a standing position and squatting at the lowest point is preparation, the body tries to position it in a favorable position for the next action and stores energy in the muscles. Then the movement is continued with a take off which has a structured and

Table 2: Squat Jump Height.

Position	Squat Jump Height (cm)	Mean difference	Sig.
Goalkeeper	49.00 ± 1.55	2.67	0.01*
Field player	46.33 ± 1.37		
* significance at 0.05			

Table 3: Squat Jump Parameters.

Parameters	Stage	Parameters	*Mean* ± SD	*Sig.*
Kinematics	Jump start	Shoulder angle at jump start (θ_{bjs})^0	27.78 ± 14.47	0.636
		Torso angle at jump start (θ_{tjs})^0	55.30 ± 6.72	
		Hip flexion angle at jump start (θ_{fhjs})^0	65.58 ± 8.72	
		Knee flexion angle at jump start (θ_{fkjs})^0	88.33 ± 11.22	
		Ankle angle at jump start (θ_{ajs})^0	73.78 ± 5.52	
		Hip angle at jump start (θ_{hjs})^0	67.00 ± 16.63	
		Leg width at jump start (s_{kjs}) (m)	0.33 ± 0.06	
	Take off	Shoulder angle at take off (θ_{bto})^0	143.13 ± 13.66	0.584
		Torso angle at take off (θ_{tto})^0	13.82 ± 5.89	
		Hip extension angle during take off (θ_{ehto})^0	160.95 ± 6.93	
		Knee extension angle during take off (θ_{ekto})^0	172.43 ± 5.29	
		Ankle angle during take off (θ_{ato})^0	140.25 ± 4.81	
		Initial speed at take off (v_o) (m/s)	3.85 ± 0.14	
	Top of jump	Shoulder angle at top of jump (θ_{btj})^0	166.50 ± 12.19	0.507
		Torso angle at top of jump (θ_{ttj})^0	6.14 ± 4.70	
		Hip extension angle at top of jump (θ_{ehtj})^0	169.08 ± 6.27	
		Knee extension angle when top of jump (θ_{ektj})^0	172.78 ± 10.72	
		Ankle angle at top of jump (θ_{atj})^0	138.34 ± 7.28	
Kinetics	Power (J/s)		334.80 ± 45.95	0.000* (*R-square*: 0.977)
	Work (J)		212.23 ± 35.84	
	Force (N)		173.43 ± 25.67	
* significance at 0.05				

synchronized movement with all the feet and hands together going up and trying to reach the highest point. The highest point becomes the top of jump which involves time in the air. Squat jumps are often used as a field test of leg strength, so movements must be fast and strong and coordinated to produce a successful and high jump [10]. The study of biomechanics in the squat jump helps improve performance and reduce the risk of athlete injury. Improving performance means increasing the effectiveness of movement. The results showed that the goalkeeper had a higher jump than the field player (49.00 ± 1.55 cm for the goal keeper; 46.33 ± 1.37 cm for the field player. In line with the research results, the review of Perez-Arroniz et al [11], explained that the jump was factors that determine the performance of a goalkeeper.

Based on these differences between the two playing positions, the kinematics parameters of the squat jump stages do not contribute to variations in jump height in the two playing positions. To show the difference between the two playing positions in the squat jump stage, treatment may be needed. This is similar to the study of Connell [12] that a higher improvement occurred in the upper extremity treatment group after undergoing 4 weeks of plyometrics. The increase occurred in jump height, active range of motion of the shoulder joint, ω peak shoulder frontal, and ω peak shoulder.

While the kinetic parameters contributed 97.7% (R-Square: 0.977) to the variation of jump height in both playing positions. Squat jump kinetic parameters are described by power of 334.80 ± 45.95 J/s, work of 212.23 ± 35.84 J, and force of 173.43 ± 25.67 N. In this case it is explained that the contribution of the kinetic parameters of power, work and force in the implementation of squat jumps was developed by lower limbs extensor muscles during squat jumps in field conditions. Samozino et al [8] showed that greater work, power, and joint moment at the hip, knee, and ankle resulted in higher jumps. Vanezis and Lees further explained that rather than technique, higher jumps are produced by greater muscle power and the development of power in the lower limb joint. Vanezis and Lees concluded that better vertical jump performance is determined by lower limb muscle power and technique plays a small role [9].

Conclusion

Based on the data analysis that has been done, it can be concluded that the goalkeeper showed a better squat jump performance than the field player. The difference in the height of the goalkeeper's squat jump and the field player is influenced by kinetic parameters (power, work, and force) of 97.7%.

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