Coach Education: The Relationship between Lower Extremity Flexibility and Vertical Jump Performance in Soccer

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Abstract
The aim of this study was to investigate the relationship between lower extremity flexibility values and vertical jump performance of elite soccer players. Twenty-six young elite male soccer players voluntarily participated in the study. Age, height, and weight of the participants were determined as descriptive statistics. Lower extremity flexibility (.=ROM) test and vertical jump (counter movement jump=CMJ) performance determination test were applied to the participants. A goniometer was used for lower extremity flexibility measurement and My Jump 2 application, which has proven its validity and reliability, was used for CMJ performances. Descriptive characteristics of the participants included in the study were mean age: 16.23 ±.51 years, height: 172.96 ±7.56 cm, body weight: 63,15±7,69 kg. The mean values of CMJ performance of the participants were: 37,54±5,51; the mean value of lower extremity flexibility angles (ROM) was 115±4,99°. According to the data obtained, a statistically significant relationship was observed between ROM and CMJ performance characteristics of elite soccer players (p=.008) (p<0.05). According to the results obtained, a significant relationship was found between ROM and CMJ performances of soccer players. It can be said that teaching the importance of flexibility exercises to soccer players in soccer training programs and including them in training programs will positively affect the sudden power output performances of soccer players such as jumping.
Keywords: Soccer, Flexibility, Vertical Jump

Introduction

Soccer is a sport branch that requires speed, agility, jumping, positive and negative accelerations at different times, requires high intensity effort, endurance must be maintained for a long time, and aerobic and anaerobic energy systems are used (Shephard, 1999). As in every sport branch, it is known that in soccer, it is extremely important to have flexible, balanced and strong muscle basic strength levels in the lower extremities in terms of optimal performance and injury prevention. Because Hamstrings and Quadriceps muscle groups, which are among the lower extremity muscle groups, play an important role in acceleration, deceleration, jumping, falling from the air to the ground and other physical activities (Willigenburg et al., 2015). The quadriceps femoris, the only extensor muscle of the knee joint, plays an important role in performing dynamic movements in the lower extremity. This muscle group stabilizes the knee joint through the patella and patellar tendon. While the quadriceps muscle group plays an important role in jumping, balance and kicking movements, the hamstring muscle group helps to perform basic physical movements such as running movements and turns, and prevents lower extremity injuries by maintaining joint stabilization due to its position. It is very important for athlete performance that the lower extremity muscles are strong, flexible and at the same time the joint range of motion (ROM) increases. The goniometer, which is used to measure

the range of motion of the lower extremities, is a frequently used and applied measurement tool in the literature. Many studies have shown that physical and technical characteristics (speed, jumping, agility and balance) improve depending on ROM range of motion. Therefore, it is possible to say that the increase in the athlete's performance requires optimal ROM values (Cejudo, 2021).

Review of Literature

As in other performance-based sports, it is known that vertical jumping abilities are closely related to the physical characteristics of soccer players (Wisloff et al., 2004). In the literature, it has been observed that anthropometric characteristics of athletes such as body composition, lower extremity strength, flexibility and jumping technique directly affect vertical jump performance (García-Pinillos et al., 2015; Chrıstou et al., 2006; Davis et al., 2003; Zanini et al., 2020; Blackburn & Morrissey, 1998). At the same time, many studies show that lower extremity strength levels of athletes have a positive relationship with vertical jump (CMJ) performance. CMJ has been used as a reference for the development of muscles of the lower extremities and different types of muscles (Nuzzo et al., 2008; Sheppard et al., 2008).

In the literature, the CMJ test is known as the most commonly used vertical jump technique that determines not only heights but also force and time curves to evaluate the neuromuscular function of athletes (McMahon et al., 2018). With this test, current performance values of athletes can be determined and training programs can be prepared. In soccer, where speed, power and jump performance characteristics are important, it is thought that the inclusion of training practices for flexibility of knee and hip flexors in training programs can be effective in improving both flexibility and vertical jump performance of soccer players (Donti et al., 2014). Therefore, the aim of this study was to investigate whether there is a relationship between lower extremity flexibility (ROM) values and vertical jump performance of elite soccer players.

Methodology

The study included 26 young elite male soccer players who had been interested in soccer for at least 2 years. After informing the elite soccer players about the purpose and method of the study before starting the study, the age, height and weight of these soccer players were determined as descriptive statistics.

The height of the elite soccer players was measured with a stadiometer (Seca, Germany) with a precision of 0.01 m in an anatomical posture, barefoot, with the heels of the feet together, with the subject holding his/her breath, with the head in the frontal plane, with the overhead table touching the vertex point, and the values were recorded in 'cm'.

Body weight measurements of elite soccer players were taken with a stadiometer (Seca, Germany) with a precision of 0.01 m, with only shorts on, barefoot and in anatomical posture and recorded in 'kg'.

Elite soccer players underwent a standardized 10-minute warm-up consisting of running, lower extremity dynamic warm-up movements and vertical jumps. These soccer players were asked to perform a rapid kneeling movement from the knees downward in a normal upright posture with hands at the side and then jump upward with maximal force. Each soccer player's vertical jumps were recorded with a high-speed camera in the validated My Jump 2 application using an iPhone 13 (Apple Inc USA) phone (Balsalobre-Fernandez et al., 2015). Each soccer player was asked to make 3 vertical jumps as high as possible. A passive rest period of 2 minutes was given at the end of each jump. The take-off and landing of the elite soccer players' feet were determined from the video. Jump distances were then calculated using the equation that determines the jump height (h= t2 x 1.22625). The best results were evaluated (Bosco et al., 1983).

To determine the hip flexion angles of the participants, a standard goniometer was used to manually measure the right lower extremity in the flexion position of the hip. In the supine position of the athlete, it was ensured that the adduction, abduction and rotation angles of the hip joint were 0° and the knee joint was in the full extension position. The pivot point of the goniometer was placed on the lateral surface of the hip with reference to the apex of the trochanter major. The fixed arm of the goniometer was placed along the lateral midline of the abdomen with reference to the pelvis and the movable arm was aligned on the lateral midline of the femur. ROM

values of elite soccer players performing voluntary maximal hip flexion were determined and recorded (Norkin & White, 2016).

Data Analysis

Descriptive characteristics, arithmetic means (X), standard deviations (SD) were determined in accordance with the data obtained from elite soccer players. The relationship between the mean values of CMJ and lower extremity flexibility angles (ROM) of elite soccer players was analyzed by Pearson Correlation test. Significance level was accepted as $p<0.05$. All tests were performed using IBM-SPSS 21 statistical software.

Results

The results of the data collected from 26 young male elite soccer players who participated in the study are presented in the form of tables below.

Table 1 Descriptive Characteristics of Male Elite Soccer Players

Descriptive Characteristics	Male Elite Soccerers (n=26)
Age (years)	16,23 ±,51
Height (cm)	172,96 ±7,56
Weight (kg)	63,15±7,69

(Kg: kilogram, cm: centimeter, n: number of individuals)

Considering the kurtosis and skewness values, it was determined that the data were outside the range of +1.5/-1.5.

Table 2 Mean Values of CMJ Height and Lower Limb (Hip Flexion=ROM) Flexibility Angles of Male Elite Soccer Players

CMJ Height Values (cm) / (n=26)	Hip flexion angle (°) / (n=26)
37,54±5,51	115±4,99

(cm: centimeter, °: degree, n: number of individuals)

According to the data obtained, there was a statistically significant relationship between hip flexion flexibility angles (ROM) and CMJ performance characteristics of male elite soccer players ($p=.008$) ($p<0.05$). According to these results, it can be said that flexibility training has a positive effect on the jump performance of elite soccer players.

Discussion

The hypothesis of this study was that the inclusion of lower extremity flexibility (ROM) training in the training programs of elite male soccer players would have a positive effect on their jumping performance. As a result of the findings obtained in this study, it was observed that lower extremity flexibility (ROM) performance characteristics of elite soccer players contributed positively to their vertical jump (CMJ) height.

It is known that vertical jump height in athletes is closely related to lower extremity flexibility and explosive performance. This jumping ability in athletes also brings physical success (Buchheit et al., 2010; De Villarreal et al., 2011). In the literature, many devices and methods have been developed to measure a trait that is so important for performance in a valid and reliable way. It has been shown that the MyJump 2 smartphone application, which can be purchased from the Apple Store (Apple Inc., USA), can easily, accurately and reliably measure vertical jump height. The use of this application in this study was economical and convenient (Turgut et al., 2018; Bosco et al., 1983). The mean CMJ height values obtained from 26 male elite soccer players with this device were 37.54±5.51 (cm). It was seen that the data we obtained were relatively close to the CMJ values (CMJ height mean values 43.9 +4.8) in the study conducted by Mujika et al. (2009) with 24 elite soccer players with an average age of 17 years (Alves et al., 2010; Mujika et al. 2009). In another study, the mean CMJ height values of 43 male soccer players aged 14-18 years were 35.16±3.97 (cm) in the flexible group and 31.47± 5.73 (cm) in the inflexible group (García-Pinillos et al., 2015). With this study, it can be thought that especially lower extremity flexibility (ROM) training contributes positively to the vertical jump performance of soccer players.

Researchers and coaches know the importance of lower extremity flexibility, which positively or negatively affects the sportive performance of soccer players who compete in every position on the soccer field. (Oberg et al., 1984). According to our results, the mean values of lower extremity hip flexion flexibility angles (ROM) of 26 male elite soccer players were 115±4.99°. In a study, 37 male soccer players showed a significant increase in vertical jump

performance as a result of 8 weeks of regular dynamic flexibility training (Turki-Belkhiria et al., 2014). In another study, it was reported that flexibility training at an early age will play a key role in improving important soccer-specific performance criteria such as speed, agility, and vertical jump (García-Pinillos et al., 2015). In the literature, it has been observed that the application of lower extremity stretching exercises lasting 30 seconds each before training in young soccer players caused an improvement in their lower extremity flexibility angles (ROM) (Zakas, 2005). In another study, the mean lower extremity ROM of 41 elite soccer players was found to be 90.9° ± 13° (Rahnama et al., 2005). At the same time, in line with the data of this study, there was a statistically significant relationship between lower extremity hip flexion flexibility angles (ROM) and CMJ performance characteristics of male elite soccer players ($p=.008$) ($p<0.05$).

Conclusion

As a result, coaches need to provide necessary training on flexibility training to soccer players and their families at an early age. Incorporating flexibility into the training program of soccer players along with other motoric performance features is extremely important for the development of optimal athletic performance. It is thought that learning the findings obtained in this study and future studies by coaches can make important contributions to the preparation of better training programs and the organization of exercise programs. According to the results obtained in this study, it can be said that giving importance to flexibility training in soccer training programs will have a positive effect on sudden power output performances such as jumping. It should not be forgotten that the development of vertical jump heights of soccer players with the support of flexibility training programs is closely related to the knowledge of coaches on this subject.

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