The effect of hip training on dynamic balance in young football players

El efecto del entrenamiento de cadera en el equilibrio dinámico de jóvenes futbolistas

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Abstract

Objective: This study was to determine hip muscle training programs on dynamic balance and in young football players.
Methods: The subjects were 22 young football players in the sports school of Nakhon Ratchasima, aged 15-18 years, randomly divided into 2 groups of 11 and trained 3 days a week for 8 weeks. The experimental group was training in a hip muscle training program (age 17.70 ± 1.15 years, high 172.36 ± 5.40 cm, body weight 59.60 ± 5.29 kg, bmi 19.92 ± 1.29), and the control group was only under a normal training program (age 17.60 ± 1.17 years, high 173.89 ± 5.62 cm, body weight 70.42 ± 8.29 kg, bmi 22.73 ± 3.12). Both groups were examined for within-group statistical data by the one-way ANOVA with repeated measures, and the independent samples t-test was conducted before, after 4 weeks, and after 8 weeks between groups at a statistical significance level of 0.05.
Results: Data showed that hip muscle strength in all movements and the dynamic balance by the star excursion balance test, especially in the anterior, anterolateral, posterolateral, and anteromedial directions of the right leg and the anterolateral and posteromedial directions of the left leg after 4 weeks and 8 weeks, were higher than before training ($p < 0.05$).
Conclusions: The findings suggest that the hip muscle training program can improve dynamic balance, and there is a strong positive correlation between hip muscle strengthening and balance in young football players.

Keywords

Hip muscle; strength training; balance control; football players.

Resumen

Objetivo: Este estudio tuvo como objetivo determinar la eficacia de los programas de entrenamiento de la musculatura de la cadera en el equilibrio dinámico de jóvenes futbolistas.
Métodos: Los participantes fueron 22 jóvenes futbolistas de la Academia Deportiva Nakhon Ratchasima, de entre 15 y 18 años, divididos aleatoriamente en dos grupos de 11 participantes. Entrenaron 3 días a la semana durante 8 semanas. El grupo experimental (edad: 17,70 ± 1,15 años, estatura: 172,36 ± 5,40 cm, peso: 59,60 ± 5,29 kg, IMC: 19,92 ± 1,29) recibió entrenamiento de la musculatura de la cadera, mientras que el grupo control (edad: 17,60 ± 1,17 años, estatura: 173,89 ± 5,62 cm, peso: 70,42 ± 8,29 kg, IMC: 22,73 ± 3,12) recibió entrenamiento de la musculatura de la cadera. Se examinaron los datos estadísticos intragrupales de ambos grupos mediante un ANOVA unidireccional con medidas repetidas. Se realizó una prueba t para muestras independientes antes, después de 4 semanas y después de 8 semanas entre los grupos, con un nivel de significación estadística de 0,05.
Resultados: Los datos mostraron que la fuerza muscular de la cadera en todos los movimientos y el equilibrio dinámico mediante la prueba de equilibrio de excursión en estrella, especialmente en las direcciones anterior, anterolateral, posterolateral y anteromedial de la pierna derecha y en las direcciones anterolateral y posteromedial de la pierna izquierda, fueron mayores después de 4 y 8 semanas que antes del entrenamiento ($p < 0,05$).
Conclusiones: Los hallazgos sugieren que el programa de entrenamiento muscular de la cadera puede mejorar el equilibrio dinámico y que existe una fuerte correlación positiva entre el fortalecimiento muscular de la cadera y el equilibrio en jóvenes futbolistas.

Palabras clave

Músculo de la cadera; entrenamiento de fuerza; control del equilibrio; jugadores de fútbol.

Introduction

Football is a sport in movement patterns from high-intensity to low-to-moderate movement such as, sprinting, jumping, shooting, accelerating, and decelerating jogging, walking and standing (Clemente et al., 2019). The risk of injuries during practice of game is high. Injuries in a football player from 2.7 - 4.5 /1000 hours of practice and range from 12.3 - 24.7 /1000 hours of match games (Kokic et al., 2023) with strain and sprain injuries constitution more than one and half of all collegiate injuries that require athletic trainer attention. The major of football has relationship with injuries around 68 to 88% in the lower extremities (Ekstrand et al., 2011). Several factors are related to non–contact injury, including age, gender, body morphology, muscle strength, flexibility, joint stability, and balance. These factors require management to reduce the risk factors that may contribute to injuries in football players. Balance, in particular, requires postural control during movement. Postural control is the ability to maintain the body's center of gravity above the base of support. Dynamic balance defines an individual's ability to maintain overall balance. Balance exercise programs are primarily focused on sports performance and preventing injury. (Bruhn et al., 2004).

Center of gravity and body stability during movement are essential for maintaining balance and equilibrium, controlled by neuromuscular function. This is often used to prevent injuries and assess outcomes when returning to sport. (Plisky et al., 2021). Balance is fundamental of complex movements technical perform by football players and important to achieve a high level of performance (Ricotti, 2011; Schedler et al., 2020), suggested that youths have a great capacity for developing static and dynamic balance.

Hip abductor and rotator movement of the hip muscle group are necessary for unilateral limb support activities involved in football to avoid excessive hip adduction and internal rotation (Winter & Eng, 1995). Hip flexor strength is very important for athletic performance (Serin, 2017). Having strong hip flexors and extensors is highly effective (Neto et al., 2019), as it can improve technical posture and reduce competition time. Muscle strength having high levels in the hip abductors and adductors improves stabilization and changes of direction (Karatrantou et al., 2019). The “position of no return” from hip adduction, internal rotation is tibial external rotation and valgus knee is referred to as being responsible for many injuries including anterior cruciate ligament injury (Ireland, 2002).

Previous studies have indicated that the high-speed, high-intensity movements of football players may increase the risk of knee and hip muscle injuries (Chena et al., 2022; Konefał et al., 2023). Especially when athletes perform high-intensity horizontal decelerations, it may damage the tissues and neuromuscular system, leading to injury to the athletes (McBurnie et al., 2022). The increased knee and hip muscle strength of properly trained football players can enhance their stable movement performance, and enable them to perform their playing skills more efficiently and prevent injuries (Franca et al., 2024). Hip muscle strength had related to decreased injury of musculoskeletal during training and competition match game (Turner & Stewart, 2014), an intense sport that may cause injury, especially in the lower limb. The purpose of this study was to investigate the effect of hip muscle training on dynamic balance in young football players. The current data will help athletes to have strong hip muscles to perform dynamic balance and prevent potential injuries, which is an important factor for football players.

Method

Participants

The participants used in this study were 22 young football players. All subjects underwent a pre-exercise readiness assessment to show that they were healthy and without any chronic health conditions. The inclusion criteria were that the football players were aged 15-18 years, trained regularly, had no history of surgery or musculoskeletal injuries, and passed the physical activity readiness questionnaire (PAR-Q). The exclusion criteria were that they had suffered an accident causing musculoskeletal injuries during their participation in the project. Participants were divided into 2 groups: The experimental group was trained 3 days a week for 8 weeks in a hip muscle training program before warming up and after following the normal training program (n = 11, age 17.70 ± 1.15 years, high 172.36 ± 5.40 cm, body weight 59.60 ± 5.29 kg, bmi 19.92 ± 1.29) and the control group was only under a normal training program, with two people dropping out of the study (n = 9, age 17.60 ± 1.17 years, high 173.89 ± 5.62 cm, body weight 70.42 ± 8.29 kg, bmi 22.73 ± 3.12) as show in Table 1. The sample size used in this study was conducted based on a review of past literature by Gidu et al. 2022, using the open-source software G*Power (version 3.1.9.7, Kiel, Germany) with an alpha error probability of 0.05 and a power of 0.95, divided into two groups and two time points. The calculated sample size was 16 people, and to prevent the dropout, the sample size was increased by 20 percent to a total of 22 people. Using purposive sampling, the researchers used a sample of athletes to test muscle power as a key sports performance criterion of hip abductions in the side-lying position and moved 3 times in each direction with non-dominant leg movements, and recorded the test results, using the results of the test to rank the ability of the muscles from the most to the least. Individually matched subjects with similar hip abductor muscle strength of non-dominance leg side were then divided into two groups of each. This research has been reviewed by Khon Kaen University Ethics Committee for Human Research based on the Declaration of Helsinki and the ICH Good Clinical Practice Guidelines. (HE 672056), and all participants provided written informed consent prior to voluntary participation.

Procedure

The test subjects had to measure body weight and height to take off their shoes before weighing. The unit of measure is kilograms measuring weight and height using a digital scale (SECA 769) for weight and a portable stadiometer (SECA 206®; Hamburg, Germany) for height.

Before starting the study, participants were given detailed instructions about the measures and all data collection. Both groups were measured on all variables three times: the first time before, the second time after 4 weeks, and the third time after 8 weeks of the experiment, as follows:

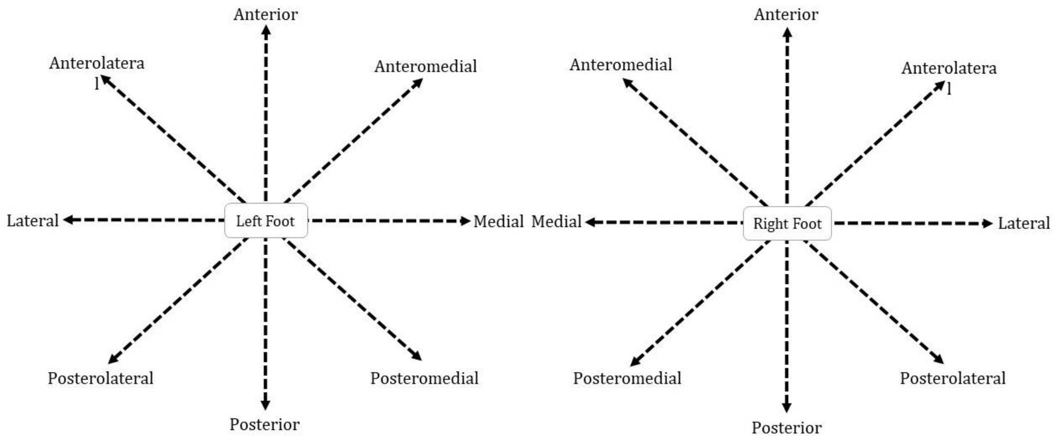
Dynamic Balance: Dynamic Balance test performed with Star Excursion Balance Test (SEBT). SEBT is an inexpensive, quick method of measuring balance, with good reliability reported (Plisky et al., 2006). The subjects performing the test must maintain a balance on one leg while using the other leg to reach as far as possible in 8 different directions. The subjects must reach in 8 different positions (anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral) (Figure 1) (Olmsted et al., 2002).

In each test on one leg in the same direction (right leg; dominant, left leg; non-dominant), there was a 15-second rest period between tests and a 1-minute rest period between reaching in different directions, e.g., test 1; right leg, front direction 15-second rest, test 2; right leg, front direction 15-second rest, test 3; right leg, front direction 1-minute rest (change of direction).

A trial was disregarded and repeated if (1) the participant was unable to maintain a single leg stance, (2) the heel of the stance foot did not remain in contact with the floor, (3) weight was shifted onto the reach foot, or (4) the participant did not maintain start and return positions for one full second. Reach distances for each direction's three trials were averaged and normalized to limb length (%LL, cm) which was measured from the anterior superior iliac spine to the medial malleolus bilaterally (Gordon et al., 2013). The trial was discarded and repeated if the player (1) failed to maintain a unilateral stance, (2) lifted or moved the stance foot from the grid, (3) touched down with the reach foot, or (4) failed to return the reach foot to the starting position. Before the test, participants performed a warm-up consisting of jogging, walking lunges, light high knee pulls to the chest, alternating trunk rotations, and arm swings.

The process was repeated while standing on the other leg. The greatest of 3 trials for each reach direction was used for the analysis of the reach distance in each direction. Also, the greatest reach distance from each direction was summed to yield a composite reach distance for analysis of the overall performance on the test.

Figure 1. Star excursion balance test.



Hip Muscle Strength Training Program

Hip strength training was performed three days a week for eight weeks prior to the regular training program. The hip strength training program consisted of 12 exercises, including single leg raise, bridging and opening hips, hip external rotation, hip abduction, kneeling squat, full kick back, donkey kick, deep squatting hold and open hip, marche, side lunge with full sidekicks, front kick to the air, and walk squat to the side. In weeks 1-4, each exercise was performed 10 times, 3 sets, rest between exercises for 60 seconds, and in weeks 4-8, each exercise was performed 15 times (75% of 1RM), 4 sets, and rest between exercises for 30 seconds, before the regular daily football training program.

Data analysis

All tests in this study data analysis using SPSS version 22.0. The Independent Samples t-test of before, after 4 weeks, and 8 weeks between group and one-way ANOVA with repeated measures within the group before, after 4 weeks, and 8 weeks at the statistical significance level of 0.05.

Results

The results of the dynamic balance star excursion test of the right foot in 8 directions, including anterior (AT), anterolateral (ATL), lateral (LT), posterolateral (PTL), posterior (PT), posteromedial (PTM), media (MD), and anteromedial (ATM) direction, showed that in the experimental group after 4 weeks (PTL, $p = 0.04$, PT, $p = 0.02$, and ATM direction, $p = 0.01$), and after 8 weeks (AT, $p = 0.01$, ATL, $p = 0.01$, LT, $p = 0.01$, PTL, $p = 0.01$, PT, $p = 0.01$, PTM, $p = 0.03$, MD, $p = 0.04$, and ATM direction, $p = 0.01$), there was a significant improvement from before ($p < 0.05$) and after 8 weeks (AT, $p = 0.03$, ATL, $p = 0.04$, LT, $p = 0.04$, PTL, $p = 0.01$, MD, $p = 0.01$ and ATM direction, $p = 0.02$), there was a significant improvement from 4 weeks ($p < 0.05$), in the control group, after 4 weeks (PTL direction, $p = 0.04$), there was significantly better than before ($p < 0.05$), and after 8 weeks (AT direction, $p = 0.03$), there was significant difference better than the 4 week ($p < 0.05$). When comparing the groups, it was found that after 8 weeks, the experimental group had significantly better dynamic balance ($p < 0.05$), in the AT, $p = 0.01$, LT, $p = 0.02$, and PTL direction, $p = 0.01$ than the control group, as shown in Table 2.

Changes in dynamic balance star excursion performance in the left foot after hip muscle training in the experimental group were found to improve after 4 weeks (ATL, $p = 0.04$, PTL, $p = 0.01$, PTM, $p = 0.03$, ATM, $p = 0.01$), after 8 weeks (AT, $p = 0.01$, ATL, $p = 0.01$, PTL, $p = 0.02$, PTM, $p = 0.01$, MD, $p = 0.01$, and ATM direction, $p = 0.01$), there was a significant improvement from before ($p < 0.05$) from before, and after 8 weeks (ATL, $p = 0.01$, PT, $p = 0.01$, PTM, $p = 0.02$, and MD direction, $p = 0.01$), there was a significant improvement from 4 weeks ($p < 0.05$), in the control group, after 4 weeks (AT direction, $p = 0.01$), there was significantly better than before ($p < 0.05$). No differences were found when comparing between groups, as shown in Table 3.

Table 1. Changes in performance dynamic balance star excursión of the right foot in the experimental and control groups.

Direction (cm)	Experiment group (n = 11)			Control group (n = 9)		
	Before	4 weeks	8 weeks	Before	4 weeks	8 weeks
Anterior	79.81 ± 10.55	82.75 ± 12.26	89.08 ± 9.49*, ** †	80.68 ± 8.02	78.82 ± 8.39	77.61 ± 7.83**
Anterolateral	66.22 ± 8.08	69.22 ± 10.25	76.64 ± 13.35*, **	62.17 ± 9.66	65.57 ± 9.05	68.62 ± 11.66
Lateral	80.14 ± 9.62	81.88 ± 11.79	86.88 ± 10.73*, ** †	72.05 ± 11.28	72.44 ± 11.91	76.24 ± 8.43
Posterolateral	83.84 ± 11.06	86.58 ± 8.75*	93.63 ± 6.72*, ** †	77.30 ± 11.43	80.04 ± 9.53*	82.97 ± 6.93
Posterior	89.55 ± 6.99	91.47 ± 6.70*	91.96 ± 7.52*	83.19 ± 10.60	84.06 ± 10.74	82.80 ± 6.16
Posteromedial	88.17 ± 5.79	88.40 ± 5.97	91.78 ± 6.63*,**	83.41 ± 10.27	82.74 ± 7.19	83.15 ± 7.48
Medial	87.01 ± 7.24	87.86 ± 6.33	91.34 ± 7.54*,**	82.37 ± 9.96	81.53 ± 9.10	82.76 ± 8.91
Anteromedial	79.10 ± 8.17	80.38 ± 8.41*	83.76 ± 8.43*, ** †	76.04 ± 9.99	75.15 ± 9.64	76.74 ± 13.38

Significant difference, from before (*p < 0.05), 4 weeks (*p < 0.05), between group (†p < 0.05).

Table 2. Changes in performance dynamic balance star excursión of the left foot in the experimental and control groups.

Direction (cm)	Experiment group (n = 11)			Control group (n = 9)		
	Before	4 weeks	8 weeks	Before	4 weeks	8 weeks
Anterior	81.37 ± 12.24	83.32 ± 9.19*	90.14 ± 5.80*	73.53 ± 7.58	79.95 ± 11.82*	84.40 ± 9.50
Anterolateral	70.47 ± 12.98	71.93 ± 12.98*	75.38 ± 11.32*, **	70.72 ± 8.05	67.55 ± 6.13	73.40 ± 9.17
Lateral	80.16 ± 12.13	81.44 ± 11.45	81.11 ± 12.85	79.12 ± 9.76	75.43 ± 10.32	76.88 ± 8.52
Posterolateral	83.27 ± 13.57	84.08 ± 12.39*	84.88 ± 13.55*	85.84 ± 9.59	82.48 ± 11.09	80.39 ± 8.53
Posterior	90.76 ± 91.98	90.23 ± 7.99	92.14 ± 7.65**	88.96 ± 7.98	92.32 ± 12.33	91.98 ± 9.18
Posteromedial	87.06 ± 11.87	91.18 ± 10.10*	97.45 ± 8.96*,**	88.81 ± 8.87	93.84 ± 12.51	96.28 ± 7.95
Medial	88.54 ± 7.90	88.68 ± 9.49	96.06 ± 7.63*,**	85.94 ± 12.06	88.66 ± 11.26	90.73 ± 7.52
Anteromedial	81.28 ± 9.53	88.68 ± 9.49*	90.41 ± 10.38*	82.42 ± 12.36	83.94 ± 10.90	86.55 ± 8.30

Significant difference, from before (*p < 0.05), 4 weeks (*p < 0.05), between group (†p < 0.05).

Discussion

Dynamic balance by star excursion balance test on the right foot (dominant side) we found in the experimental group, statistically significant change (p < 0.05) distance of test are increase except direction of posterolateral, posteromedial, anteromedial direct of right foot are significantly after 8 weeks can improve dynamic balance, which the football players perform better in anterior, anterolateral, lateral, posterolateral, posterior, posteromedial, medial, and anteromedial directions of the SEBT on the dominant foot and its relation to football movements. In football, players heavily rely on their dominant leg for kicking, passing, shooting, changing direction, and maintaining balance (Ronnestad et al., 2008; Ricotti, 2011; Schedler et al., 2020). This results in greater strength, control, and neuromuscular efficiency on the dominant side, leading to better performance in the SEBT. Relationship between SEBT directions and football-specific movements in posterolateral and posteromedial directions (diagonal backward movements). These movements are essential for changing direction quickly (cutting movements), when dribbling or defending and they are backpedaling to track opponents while maintaining balance, they stabilize the dominant foot when making quick lateral shifts or lungs (Matjaz et al., 2025). Since football requires constant side-stepping, pivoting, and defensive positioning, players develop superior strength and balance control in these directions on their dominant foot and anteromedial direction (diagonal forward-inward movements).

The data obtained from this study showed that after hip muscle training, after 4 weeks, the football players had better dynamic balance, and after 8 weeks, the football players had better dynamic balance significantly (p < 0.05). This movement is closely related to kicking, passing, and shooting mechanics, where the dominant foot provides the necessary force and control, such as dribbling and attacking plays, as players push off their dominant foot to generate speed and maneuver around opponents because these movements are frequent and essential in football, players naturally develop better control and balance in the anteromedial direction. (Emmonds et al., 2019). However, reasons for better performance on the dominant foot, which hip muscle strength and stability, with the gluteus medius, gluteus maximus, and hip flexors on the dominant foot being significantly stronger due to repetitive kicking and balance-maintaining movements: stronger hip muscles contribute to greater reach and stability (Trecroci et al., 2019). Neuromuscular control after hip muscle strength training, it can be seen that the dynamic balance star excursion test after 8 weeks in the dominant foot (right leg) and left leg of the football players has changed for the better in all directions, when compared to the control group with a significance difference (p < 0.05), because they have been trained with specific muscles for appropriate movement, allowing the athletes to control movement in various directions and to activate the stabilizing muscles more accurately, resulting in the development of balance and movement to be more efficient, including creating more familiarity, confidence and experience in movement for the football players (Ricotti, 2011; Schedler et al., 2020; Serin, 2017).

Importantly, the SEBT test obtained in the current study reflects the specific movement patterns of soccer players. Soccer players performed better on the dominant foot (Table 1), as these directions are highly relevant for kicking, passing, changing directions, and defensive positioning. The stronger hip flexors, better stability, and superior neuromuscular control on the dominant side result in better balance and movement efficiency in these directions (Munro & Herrington, 2010). It is possible that the dominant foot is in better physical training condition and is used more frequently in dynamic football performance, making it naturally more efficient in performing SEBT. Finally, the results of the dynamic balance star excursion test are consistent with the demands of football movement, In both legs, especially the dominant foot playing a key role in maintaining stability and powerful and controlled movement, as well as dynamic balance with the non-dominant side. The young footballers in the experimental group performed better in the posterolateral, posteromedial, and anteromedial directions of the SEBT after an 8-week hip training program, the SEBT on the non-dominant side was better than before the training, and its relationship with football movement was better (Lee et al., 2016). Importantly, the strength of the external rotator flexors on the dominant foot improved the forward reach direction in the SEBT in football players after 8 weeks physical conditioning program. It is possible to change and enhance the efficiency of the hip muscles, which are important in maintaining the body balance of football players while moving in different desired directions (Ricotti, 2011; Bekris et al., 2012; Wilson et al., 2018).

Conclusions

The data from this study indicated that after 3 days per week of hip flexor strength training for 8 weeks in young football players, there were more changes and improvements in dynamic balance than in an untrained group. Developing hip strength improves stability and resilience to injury, making it a crucial aspect of football training programs.

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Conflict of interest

The author has no conflict of interest regarding the author or the results of other studies.

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