

Erkek Basketbol Oyuncularında Hamstring Kasına Uygulanan Derin ve Yüzeysel Kendi Kendine Miyofasyal Gevşemenin Sıçrama ve Çeviklik Performansı Üzerindeki Akut Etkileri: Randomize Dengeli Çapraz Geçişli Bir Çalışma

Acute Effects of Deep and Superficial Self-Myofascial Release Applied to the Hamstring Muscles on Jump and Agility Performance in Male Basketball Players: A Randomized Balanced Crossover Study

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Özet

Bu çalışmanın amacı, erkek basketbol oyuncularında derin ve yüzeysel kendi kendine miyofasyal gevşemenin (SMR) sıçrama ve çeviklik performansı üzerindeki akut etkilerini incelemektir. Çalışmaya 24 erkek basketbol oyuncusu gönüllü olarak katılmıştır (yaş: 21.9 ± 1.9 yıl, spor yaşı: 12.9 ± 2.5 yıl, boy uzunluğu: 193.2 ± 8.6 cm, vücut kütlesi: 91.2 ± 11.5 kg). Araştırmada randomize, dengeli, çapraz geçişli tekrarlı ölçüm deseni kullanılmıştır. Her katılımcı, randomize sırayla üç deneysel koşulu tamamlamıştır: baseline, derin SMR ve yüzeysel SMR. SMR koşullarında foam rolling uygulaması, hamstring kaslarına her bacak için 90 saniye süreyle ve 60 bpm'de standardize edilmiş bir ritimle uygulanmıştır. Countermovement sıçrama performansı Optojump sistemi kullanılarak değerlendirilmiş, Lane agility performansı ise FitnessMeter uygulaması ile kaydedilmiştir. Veriler tek yönlü tekrarlı ölçümler varyans analizi kullanılarak analiz edilmiştir. Baseline, derin SMR ve yüzeysel SMR koşulları arasında countermovement sıçrama ($p=0.168$) veya Lane agility performansı ($p=0.755$) açısından istatistiksel olarak anlamlı bir fark gözlenmemiştir. Bu bulgular, hamstring kaslarına uygulanan akut derin ve yüzeysel SMR'nin erkek basketbol oyuncularında sıçrama veya çeviklik performansını anlamlı düzeyde değiştirmediklerini ve sonraki sıçrama ve çeviklik çıktılarında bozulmaya neden olmaksızın ısınma stratejisinin bir parçası olarak kullanılabileceğini göstermektedir.

Anahtar Kelimeler: Basketbol, çeviklik, hamstring, miyofasyal gevşeme, sıçrama

Abstract

This study aimed to examine the acute effects of deep and superficial self-myofascial release (SMR) on jump and agility performance in male basketball players. Twenty-four male basketball players voluntarily participated in the study (age: 21.9 ± 1.9 years, training age: 12.9 ± 2.5 years, height: 193.2 ± 8.6 cm, body mass: 91.2 ± 11.5 kg). A randomized, balanced crossover repeated-measures design was used. Each participant completed three experimental conditions in a randomized order: baseline, deep SMR, and superficial SMR. In the SMR conditions, foam rolling was applied to the hamstring muscles for 90 seconds per leg at a standardized rhythm of 60 bpm. Countermovement jump performance was assessed using an Optojump system, and Lane agility performance was recorded using the FitnessMeter application. Data were analyzed using one-way repeated-measures analysis of variance. No statistically significant differences were observed among the baseline, deep SMR, and superficial SMR conditions for countermovement jump ($p=0.168$) or Lane agility performance ($p=0.755$). These findings suggest that acute deep and superficial SMR applied to the hamstring muscles does not meaningfully alter jump or agility performance in male basketball players and may be used as part of a warm-up strategy without impairing subsequent jump and agility outcomes.

Keywords: Agility, basketball, hamstring, jumping, myofascial release

INTRODUCTION

Basketball is a high-intensity team sport based on explosive power and characterized by frequent repetitions of sprinting, jumping, agility, change-of-direction, lateral movements, and physical contacts (Ben Abdelkrim, El Fazaa, El Ati, & Tabka, 2007; Cengizel, Cengizel, & Öz, 2020; Conte et al., 2015; Simenz, Dugan, & Ebben, 2005). These repeated movement demands require basketball players to produce substantial strength and power during acceleration, deceleration, stopping, and change-of-direction actions (Wen, Dalbo, Burgos, Pyne, & Scanlan, 2018). Basketball match-play imposes frequent multidirectional and explosive movement demands on male players. Time-motion studies have shown that basketball-specific activities such as defensive shuffling and jumping increase the physical demands of competition, while the intermittent nature of the game and repeated directional changes further elevate the metabolic load imposed on players (Ben Abdelkrim et al., 2007; McInnes, Carlson, Jones, & McKenna, 1995). In adult male basketball competition, Scanlan et al. (2011) reported that elite and sub-elite Australian male players performed approximately 42–56 jumps and 58–75 shuffling movements during match-play, indicating that both vertical and multidirectional movement actions are frequent components of game demands. Similarly, notational data have demonstrated that match activity includes substantial proportions of high-intensity running/sprinting and shuffling movements, supporting the need for performance tests and warm-up strategies that reflect repeated changes in movement direction rather than straight-line running alone (Scanlan et al., 2011; Scanlan, Dascombe, & Reaburn, 2015). Therefore, because jump actions, defensive shuffling, and repeated directional changes are central components of basketball match demands, it is important to determine whether acute hamstring-focused SMR alters subsequent jump and agility performance.

Warm-up has long been accepted as a fundamental preparatory practice for optimizing subsequent performance before exercise or training (Cengizel, 2025; Lee, Chu, Lyu, Chang, & Chang, 2018), and in recent years, self-myofascial release (SMR) has increasingly been incorporated by athletes as a warm-up strategy (Civelek, Cengizel, Savaş, & Cengizel, 2025; Kurt, Gürol, & Nebioğlu, 2023). SMR contributes to the viscoelasticity of muscles by increasing intramuscular tissue temperature and blood flow, making the fascia more fluid through heat and pressure (França, Amorim, Sinhorim, Santos, & do Nascimento, 2023). In addition, SMR is thought to influence soft tissue through several mechanisms similar to those proposed for traditional massage (Richman, Tyo, & Nicks, 2019). SMR may help reduce restrictions within fascial layers, while the mechanical pressure applied to soft tissue can

stimulate mechanoreceptors and subsequently decrease muscle and fascial tension (Russo et al., 2023). Since alterations in the mechanical properties of fascia, such as stiffness and changes in thickness, may influence flexibility and muscle contraction and limit range of motion, interventions targeting myofascial tissues may be relevant for subsequent movement performance (Bordoni & Zanier, 2015; Wilke et al., 2020). Additionally, SMR has been suggested to provide a potential warm-up effect, supporting its use before exercise or sport-specific performance tasks (Healey, Hatfield, Blanpied, Dorfman, & Riebe, 2014).

In practical SMR applications, athletes commonly use devices with different surface textures, sizes, and hardness levels, including massage sticks, massage guns, foam rollers, vibrating foam rollers, lacrosse balls, and tennis balls (Behara & Jacobson, 2017; Dębski, Białas, & Gnat, 2019; Phillips, Diggin, King, & Sforzo, 2021; Stroiney, Mokris, Hanna, & Ranney, 2020), to apply pressure to various body regions (Michalak, Kopiczko, Gajda, & Adamczyk, 2024; Monteiro et al., 2019). Foam roller (FR), in particular, are cylindrical SMR tools produced in different sizes and densities (Rivera et al., 2023). Compared with conventional smooth FRs, deep tissue rollers (DTRs) contain high-profile, semi-flexible but firm nodules designed to mimic a massage therapist's thumbs, and therefore may theoretically apply greater localized pressure because they contact a smaller surface area (Behara & Jacobson, 2017). Furthermore, although SMR tools with different densities are increasingly used in practice, the literature still lacks strong scientific evidence clearly documenting their specific effects on fascial tissue (Dębski et al., 2019).

Previous evidence suggests that incorporating FR into warm-up or pre-exercise routines may enhance selected performance-related qualities, including flexibility and muscle stiffness (Glänzel et al., 2023), while preserving muscle strength (MacDonald et al., 2013). Studies have examined the effects of foam rolling on several performance- and recovery-related outcomes, including muscle strength (Acar et al., 2022; Behara & Jacobson, 2017; Chen et al., 2023; Cornell & Ebersole, 2020; Glänzel et al., 2023; Martínez-Aranda, Sanz-Matesanz, García-Mantilla, & González-Fernández, 2024), range of motion and flexibility (Bradbury-Squires et al., 2015; Jeong et al., 2019; Monteiro et al., 2019; Monteiro, Vigotsky, Novaes, & Škarabot, 2018; Wilke et al., 2020), athletic performance (França et al., 2023; Martínez-Aranda et al., 2024), and recovery (Alonso-Calvete et al., 2022; Hendricks, Hill, Hollander, Lombard, & Parker, 2020; Skinner, Moss, & Hammond, 2020). However, a recent systematic review indicated that most studies reported no meaningful changes in performance tests after foam rolling, and several did not support foam rolling as an effective intervention for enhancing

performance (Hendricks et al., 2020). Moreover, a recent meta-analysis reported that foam rolling performed during warm-up does not acutely influence isometric muscle strength, eccentric torque, rate of force development, or myofascial tissue stiffness, although it may increase knee extensor concentric torque (Glänzel et al., 2023).

Evidence specifically derived from basketball players remains limited and suggests that the acute effects of foam rolling may depend on the performance task and outcome assessed. Yuan et al. (2023) reported improved non-dominant limb performance in a 45° Y-shaped agility task following foam rolling in male basketball players, whereas no significant improvement was observed in the 505 change-of-direction test. Similarly, Civelek et al. (2025) found selective and limb-specific responses to different foam roller textures in female basketball players, with no significant change in hamstring peak torque, a decrease in dominant quadriceps peak torque following superficial SMR, and increased non-dominant hamstring power following both superficial and deep SMR. Collectively, these findings indicate that the acute performance responses to foam rolling in basketball players may be task-, muscle-, and roller-specific rather than uniformly beneficial.

Despite the growing use of SMR as a warm-up strategy, the acute effects of different foam roller types on sport-specific performance remain unclear, particularly in basketball players. Although smooth and deep tissue rollers may differ in the amount and distribution of mechanical pressure applied to soft tissues, limited evidence has directly compared their effects on performance outcomes requiring explosive lower-limb power and multidirectional agility. Therefore, the aim of this study was to examine the acute effects of deep and superficial SMR on jump and agility performance in male basketball players. Based on previous findings indicating selective and task-specific responses to foam rolling with different roller textures (Civelek et al., 2025), no specific directional effect was hypothesized. Rather, it was hypothesized that hamstring-focused deep and superficial SMR protocols would produce different acute responses in countermovement jump and Lane agility performance compared with the baseline condition in male basketball players.

METHODS

This study employed a randomized, balanced crossover, repeated-measures experimental design. Each participant completed three experimental conditions, including baseline, deep SMR, and superficial SMR, in a randomized order. This within-subject design was preferred to reduce inter-individual variability and to allow direct comparison of performance responses across different SMR conditions.

Participants

A priori sample size estimation was performed using G*Power software (version 3.1., University of Düsseldorf, Germany) for repeated-measures ANOVA within factors. Previous randomized crossover studies investigating the acute effects of foam rolling on change-of-direction and strength-related performance in basketball players reported large effects for selected outcomes (Civelek et al., 2025; Yuan et al., 2023). However, to avoid overestimating the expected effect for countermovement jump (CMJ) and Lane Agility Test performance, a more conservative effect size was selected for the present study. The analysis was conducted with an effect size of $f=0.30$, $\alpha=0.05$, statistical power=0.80, one group, three repeated measurements, an assumed correlation among repeated measures of 0.50, and a nonsphericity correction of 1.00. The minimum required sample size was calculated as 20 participants. Therefore, the inclusion of 24 male basketball players was considered sufficient for the present randomized crossover repeated-measures design. The study group consisted of 24 male athletes who were actively involved in basketball. The inclusion criteria were as follows: (a) having at least five years of regular basketball experience, (b) being an actively licensed basketball player, (c) participating in regular basketball training at least three days per week, (d) volunteering to participate in the study, and (e) signing the written informed consent form. Athletes who had undergone surgery within the last six months, had a history of acute or chronic injury that could affect lower-extremity performance, or failed to complete the measurement protocol were excluded from the study. Lower-extremity dominance was determined based on the leg preferred by the participants for kicking a ball. The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Gazi University Ethics Committee (Research code: 2026–852).

Study Design

This study used a randomized, balanced crossover repeated-measures design to examine the acute effects of superficial and deep SMR applied to the hamstring muscles on vertical jump and agility performance. All 24 participants completed all three experimental conditions: baseline, superficial SMR, and deep SMR. Data collection was completed over four sessions. The first session included explanation of the study procedures, recording of body height, body mass, and dominant leg, and familiarization with the CMJ, Lane Agility Test, and SMR applications. During the following three sessions, each participant completed one experimental condition per session. The order of the three conditions was determined by drawing lots and was balanced so that each condition was performed in the first, second, and third experimental

session by eight participants. A minimum interval of 72 h was maintained between experimental sessions. All sessions were conducted at similar times of day under the same indoor sports hall conditions. Participants were instructed to refrain from strenuous lower-extremity exercise for 48 h before each session and to avoid caffeine and similar stimulants during the final 12 h before testing.

Warm-up Protocol

All measurement sessions began with a standardized 10-min warm-up protocol. The warm-up consisted of 5 min of jogging, 3 min of dynamic mobilization, and 2 min of static stretching. The dynamic section included 90-90 hip rotation, lying single-leg knee-to-chest dynamic stretch, lying hamstring full-extension stretch, active straight leg raise, lunge and thoracic rotation, mini skipping, high knees, single-leg high knees, dynamic straight leg, glute kicks, and walking toe touches. The static section included standing quadriceps stretch, seated hamstring stretch, calf stretch, deep glute stretch, Achilles stretch, inner hamstring stretch, IT band stretch, butterfly stretch, and hip flexor stretch.

Baseline and SMR Protocols

In the baseline protocol, after the standardized warm-up, participants remained passively in a sitting position for 3 min to match the time course of the SMR application. This was followed by 5 min of passive standing rest, matching the post-SMR recovery period used in the experimental conditions, after which the CMJ test was performed. The 5-min interval was selected based on previous studies reporting that acute changes in muscle mechanical properties may be observed within this post-intervention period (Konrad et al., 2019; Schroeder et al., 2021). The Lane Agility Test was conducted 3 min after the CMJ measurements to allow recovery from the preceding maximal-effort test and to minimize its potential influence on subsequent agility performance.

In the superficial and deep SMR protocols, the relevant FR protocol was applied to the hamstring muscle group after the standardized warm-up. In the superficial SMR protocol, a medium-density grid-surface FR measuring 30 × 15 cm was used (Adamczyk, Gryko, & Boguszewski, 2020; Monteiro & Neto, 2016). In the deep SMR protocol, a hard-density deep tissue foam roller measuring 55 × 14 cm and featuring a high-profile bump surface was used (The Rumble Roller; STI, Baton Rouge, LA, USA) (Behara & Jacobson, 2017; Michalak et al., 2024).

Participants were positioned in a seated posture with the hamstring region in contact with the FR and were instructed to roll back and forth in a controlled manner between the ischial tuberosity and the popliteal fossa (Madoni, Costa, Coburn, & Galpin, 2018). The rolling tempo was maintained at 60 bpm using a mobile phone metronome application. The level of pressure was adjusted by the participants using their own body weight, ensuring that it did not cause pain but produced only mild discomfort (Michalak et al., 2024; Monteiro et al., 2018; Peacock et al., 2015; Phillips et al., 2021). A single 90-sec application was performed for each lower extremity, resulting in a total application duration of 180 sec (Hendricks et al., 2020; Skinner et al., 2020). The starting side was randomized and balanced; the application began with the dominant side in 12 participants and with the non-dominant side in 12 participants. After completion of the SMR application, participants followed the same post-intervention testing sequence as in the baseline condition.

Countermovement Jump Test

Vertical jump performance was assessed using the countermovement jump (CMJ) test. Measurements were recorded using the Optojump Next system (Microgate, Bolzano, Italy). The Optojump photoelectric cell system has demonstrated strong concurrent validity for estimating vertical jump height compared with force plate measurements, with very high validity ICC values for CMJ performance (ICC=0.998; 95% CI=0.995–0.999). In addition, excellent test–retest reliability has been reported for CMJ height measured with Optojump (ICC=0.989; 95% CI=0.973–0.996; CV=2.2%) (Glatthorn et al., 2011). Participants began the test in an upright standing position with their hands placed on their hips and performed a maximal vertical jump following a rapid eccentric lowering movement. Each participant completed three trials, with 60 s of passive rest between trials. The highest jump height was used for the analysis.

Lane Agility Test

Agility performance was assessed using the Lane Agility Test (Figure 1). The test was performed using standard basketball half-court markings. During the test, participants completed a sequence of forward sprinting, lateral shuffling, backward running, and change-of-direction movements, while maintaining body orientation during all directional changes. Test time was recorded using the FitnessMeter application on an iPhone 14 Pro Max smartphone and evaluated in seconds. The FitnessMeter application has previously demonstrated strong validity for measuring change-of-direction performance compared with a photocell system, showing a very high correlation between instruments ($r=0.971$), no significant differences in completion times ($p>0.05$), minimal systematic bias (0.02 ± 0.05 s),

acceptable agreement, and reproducibility with coefficient of variation values below 3% (Moreno-Azze, López-Plaza, Alacid, & Falcon-Miguel, 2025). Each participant completed two valid trials, with 3 min of passive rest between trials. The shortest completion time was used for the analysis.

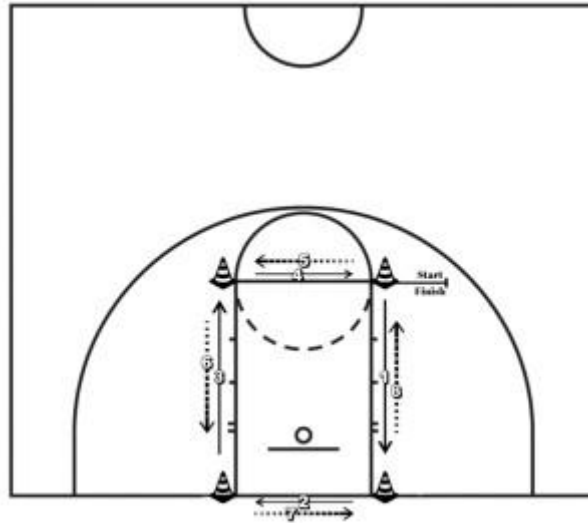


Figure 1. Schematic representation of the Lane Agility Test performed on a standard basketball half-court

Data Analysis

The normality of the data was assessed using the Shapiro–Wilk test. Descriptive statistics are presented as mean±standard deviation. Differences among the baseline, superficial SMR, and deep SMR conditions were examined separately for the CMJ and Lane Agility Test variables.

When the data met the assumption of normal distribution, one-way repeated-measures analysis of variance was used. If a significant main effect was detected, pairwise comparisons were performed using Bonferroni correction. When the normality assumption was not met, the Friedman test was used, and pairwise comparisons were examined using appropriate post-hoc tests when significance was detected. Data analysis was performed using SigmaPlot 11.0 software (Systat Software, Inc., San Jose, CA, USA). The level of statistical significance was set at $p < 0.05$.

RESULTS

The characteristics of the participants are presented in Table 1 (n=24).

Table 1. Characteristics of participants (n=24)

	mean±SD	min	max	95% CI
Age (year)	21.9±1.9	19.0	26.0	21.1-22.7
Training experience (year)	12.9±2.5	8.0	19.0	11.9-13.9
Basketball training experience (year)	11.2±2.9	6.0	16.0	10.0-12.4
Body height (cm)	193.2±8.6	175.0	210.0	189.8-196.6
Body mass (kg)	91.2±11.5	67.0	118.0	86.6-95.8
Body mass index (kg.m ⁻²)	24.4±1.9	18.9	28.9	23.6-25.2

SD: Standard deviation, min: Minimum value, max: Maximum value, CI: Confidence interval.

The descriptive statistics and repeated-measures ANOVA results for CMJ are presented in Table 2. The normality assumption was met for both CMJ ($p=0.075$) and Lane Agility Test performance ($p=0.100$).

CMJ performance did not differ significantly among the baseline, deep SMR, and superficial SMR conditions ($F(2,46)=1.858$, $p=0.168$). Mean CMJ height was 42.4±6.5 cm in the baseline condition, 43.2±6.5 cm following deep SMR, and 42.2±6.6 cm following superficial SMR. Although CMJ height was slightly higher after deep SMR compared with baseline, this difference was not statistically significant. CMJ flight time did not differ significantly among the baseline, deep SMR, and superficial SMR conditions ($F(2,46)=2.491$, $p=0.094$). Mean flight time was 0.586±0.046 sec in the baseline condition, 0.592±0.046 sec following deep SMR, and 0.584±0.047 sec following superficial SMR. Although flight time was slightly higher after deep SMR, this difference did not reach statistical significance.

Table 2. The acute effects of deep and superficial SMR applied to the hamstring muscles on jump performance in male basketball players

		mean±SD	min	max	95% CI	p
CMJ height (cm)	Baseline	42.4±6.5	23.8	55.5	39.8-45.0	0.168
	Deep SMR	43.2±6.5	26.1	58.5	40.6-45.8	
	Superficial SMR	42.2±6.6	24.3	58.5	39.6-44.8	
CMJ flight time (sec)	Baseline	0.586±0.046	0.441	0.673	0.568-0.604	0.094
	Deep SMR	0.592±0.046	0.461	0.691	0.574-0.610	
	Superficial SMR	0.584±0.047	0.445	0.691	0.565-0.603	

SD: Standard deviation, min: Minimum value, max: Maximum value, CI: Confidence interval. CMJ: Counter movement jump, SMR: Self-myofascial release.

Similarly, Lane Agility Test performance did not differ significantly among the baseline, deep SMR, and superficial SMR conditions ($F(2,46)=0.282$, $p=0.755$, Table 3). Mean agility time was 11.86 ± 0.60 sec in the baseline condition, 11.87 ± 0.70 sec following deep SMR, and 11.92 ± 0.61 sec following superficial SMR.

Table 3. The acute effects of deep and superficial SMR applied to the hamstring muscles on agility performance in male basketball players

		mean $\pm$ SD	min	max	95% CI	p
Lane agility time (sec)	Baseline	11.86 $\pm$ 0.60	10.83	13.23	11.62-12.10	0.755
	Deep SMR	11.87 $\pm$ 0.70	10.49	13.43	11.59-12.15	
	Superficial SMR	11.92 $\pm$ 0.61	10.37	13.17	11.68-12.16	

SD: Standard deviation, min: Minimum value, max: Maximum value, CI: Confidence interval. SMR: Self-myofascial release.

Compared with the baseline condition, CMJ height increased by 1.79% following deep SMR and decreased by 0.35% following superficial SMR (Figure 2). CMJ flight time showed a similar pattern, increasing by 1.02% after deep SMR and decreasing by 0.34% after superficial SMR. In contrast, Lane agility test completion time increased by 0.15% after deep SMR and by 0.53% after superficial SMR compared with baseline, indicating slightly slower performance under both SMR conditions. However, none of these percentage changes reached statistical significance.

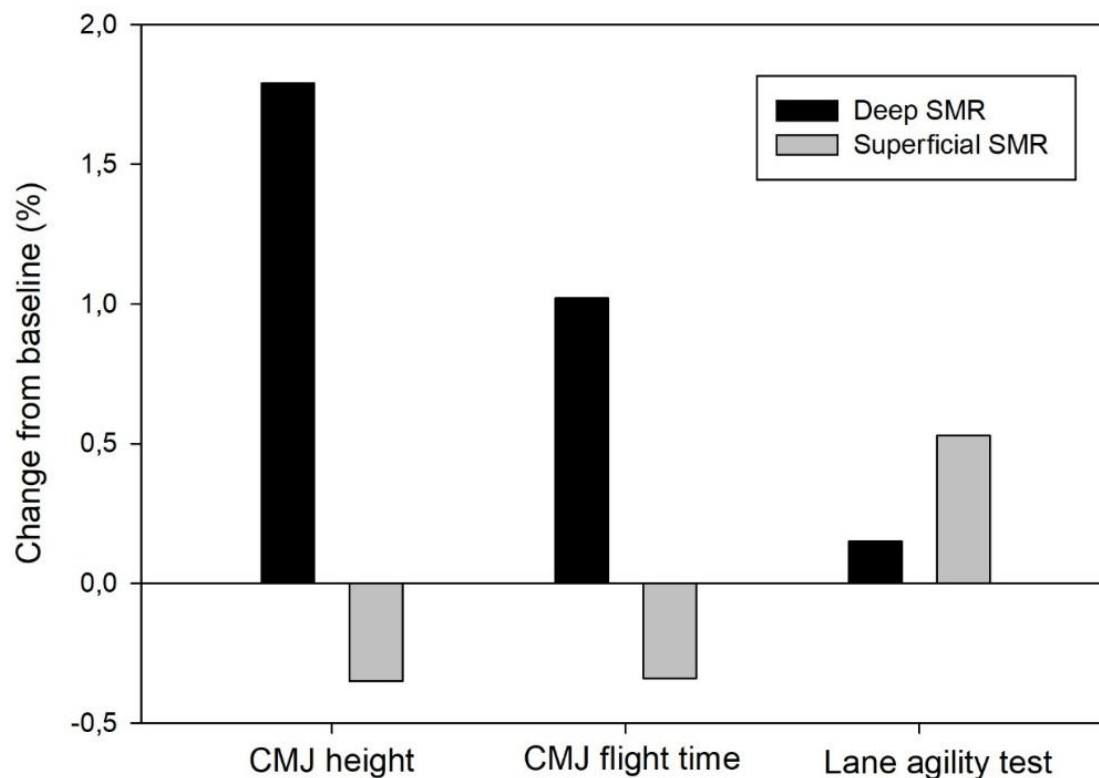


Figure 2. Percentage changes from baseline in CMJ height, CMJ flight time, and Lane Agility Test performance following deep and superficial SMR protocols. Positive values indicate an increase compared with baseline. For Lane Agility Test performance, positive values indicate longer completion time and therefore slower performance.

DISCUSSION

The aim of this study was to examine the acute effects of deep and superficial SMR on jump and agility performance in male basketball players. The main findings showed that neither deep nor superficial SMR produced a statistically significant change in CMJ height, CMJ flight time, or Lane Agility Test performance compared with the baseline condition. Accordingly, the study hypothesis was not supported, suggesting that a single-session hamstring-focused SMR application, regardless of roller type, does not acutely alter jump or agility performance in male basketball players.

In the present study, hamstring-focused deep and superficial SMR protocols did not produce a significant acute change in CMJ height or CMJ flight time in male basketball players. This finding suggests that a single 90-sec per leg SMR application to the hamstrings, regardless of roller type, may not provide a sufficient stimulus to acutely enhance vertical jump performance. This result is consistent with Koźlenia and Domaradzki (2022), who reported that

short intensive SMR produced only minor changes in jump parameters and was ineffective for directly improving jump performance. Similarly, Kyranoudis et al. (2019) found no significant interaction between foam rolling combined with static stretching and static stretching alone for CMJ performance in soccer players, suggesting that the addition of FR may not always provide an extra performance benefit. In contrast, Smoliga et al. (2025) reported a small but significant improvement in CMJ performance after a myofascial release protocol in young football players, while Wang et al. (2022) found that vibration foam rolling improved CMJ performance in tennis players. These inconsistent findings may be explained by methodological differences among studies, including the population examined, the muscle groups targeted, the duration and timing of the SMR intervention, the use of vibration, and whether SMR was applied locally or to multiple lower-limb muscle groups. In particular, the present study applied SMR only to the hamstrings, whereas CMJ performance depends on the coordinated contribution of the quadriceps, gluteal muscles, calf muscles, and trunk stabilizers. Therefore, the absence of a significant CMJ response in this study may indicate that localized hamstring SMR alone is insufficient to acutely modify a complex multi-joint explosive task such as the CMJ.

Regarding agility performance, hamstring-focused deep and superficial SMR protocols did not significantly improve Lane Agility Test performance in male basketball players. In fact, completion time showed only very small numerical increases following deep and superficial SMR, indicating slightly slower but statistically non-significant responses. This finding suggests that a single-session SMR application applied only to the hamstrings may not be sufficient to acutely enhance basketball-specific agility performance, which requires rapid acceleration, deceleration, lateral shuffling, backward running, and repeated changes of direction. Previous studies have reported inconsistent findings regarding the acute effects of SMR on agility and change-of-direction performance. Peacock et al. (2014) reported that adding a total-body SMR protocol to a dynamic warm-up significantly improved 18.3-m pro-agility performance compared with dynamic warm-up alone. Similarly, Seçer et al. (2025) observed significant pre-to-post improvements in agility, dynamic balance, and speed after different FR durations in young male soccer players, although the group $\times$ time interaction was not significant, suggesting that different FR durations did not produce clearly different effects. In male basketball players, Yuan et al. (2023) reported that FR improved non-dominant limb performance in a 45° Y-shaped agility task, whereas no significant improvement was observed in the 505 test, indicating that the effect of FR may depend on the specific change-of-direction angle, task structure, and limb involved. In contrast, Healey et al. (2014) found no significant

differences between foam rolling and a control condition for agility or other athletic performance tests, which is consistent with the present findings. These discrepancies may be explained by differences in the applied SMR protocol, including total-body versus localized application, target muscle groups, rolling duration, pressure intensity, use of dynamic warm-up components, and the agility test selected. Since the Lane Agility Test is a complex basketball-specific task involving multiple movement patterns and several lower-limb muscle groups, localized hamstring SMR alone may not have provided a sufficient neuromuscular or mechanical stimulus to meaningfully improve agility performance.

The absence of clear performance enhancement in the present study may also be interpreted in light of the selective and task-specific nature of SMR responses. Although fascial release and stretching techniques have been suggested to improve flexibility in muscle groups such as the quadriceps femoris and hamstrings (Rivera et al., 2023), improvements in flexibility or tissue compliance may not necessarily translate into enhanced explosive or multidirectional performance. For example Stroiney et al. (2020) reported that SMR applied to the hamstrings, quadriceps femoris, and triceps surae increased vertical jump performance in recreational athletes, whereas Behara and Jacobson (2017) found that deep tissue SMR improved flexibility without significantly altering strength or power outcomes. In our previous study on female basketball players, different FR textures produced selective and limb-specific effects on isokinetic strength: hamstring peak torque was not significantly altered, dominant quadriceps peak torque decreased after superficial SMR, and non-dominant hamstring power increased after both superficial and deep tissue SMR (Civelek et al., 2025). Similarly, Cavanaugh et al. (2017) suggested that foam rolling may produce an antagonistic effect, reporting reduced biceps femoris activation when only the quadriceps was rolled. Taken together, these findings indicate that SMR responses may depend on the targeted muscle group, roller type, limb dominance, and the specific performance task. Therefore, the lack of significant changes in CMJ and Lane Agility Test performance in the present study may reflect the limited transfer of localized hamstring SMR to complex whole-body performance tasks rather than the complete absence of neuromuscular effects.

The lack of significant findings may be explained by several factors. First, the SMR intervention was applied only to the hamstring muscle group, whereas CMJ and Lane Agility Test performance depend on the coordinated contribution of multiple lower-limb and trunk muscles, including the quadriceps, gluteal muscles, calf muscles, hip stabilizers, and core

musculature. Therefore, a short-term hamstring-focused SMR intervention may not have provided a sufficient neuromuscular stimulus to alter these complex performance tasks. Second, because the participants were active male basketball players, their jump and agility performance may have already been highly adapted to sport-specific explosive and multidirectional actions, limiting the magnitude of acute responses to SMR. Third, the expected effects of SMR may be more pronounced in outcomes such as flexibility, range of motion, pain perception, or tissue stiffness rather than in explosive and coordinative tasks requiring rapid force production. Finally, although deep and superficial rollers differ theoretically in terms of pressure distribution, the self-selected pressure applied by participants may have reduced the practical difference between the two SMR conditions.

From a physiological and neuromuscular perspective, the mechanical pressure generated during SMR may modify soft-tissue compliance and sensory input through stimulation of mechanoreceptors; however, such local responses may not necessarily produce changes in the rapid force production and intermuscular coordination required for CMJ and multidirectional agility performance. Previous evidence has shown that foam rolling can increase range of motion without reducing muscle activation or force production (MacDonald et al., 2013), while other findings indicate that localized rolling may alter muscle activation patterns without producing consistent improvements in performance (Cavanaugh et al., 2017). Therefore, any acute neuromuscular effects induced by hamstring-focused SMR may have been too localized or too small to influence whole-body performance tasks. Moreover, because the pressure was self-regulated and no direct measures of muscle activation, tissue stiffness, or range of motion were obtained, these mechanisms remain speculative and cannot be confirmed by the present study.

Several limitations of the present study should be acknowledged. First, the sample consisted only of active male basketball players; therefore, the findings may not be generalizable to female athletes, youth players, recreational participants, or athletes from other sports. Second, the SMR intervention was applied only to the hamstring muscle group. Since jump and agility performance depend on the coordinated contribution of multiple lower-limb and trunk muscles, the effects of SMR applied to other muscle groups or to the entire lower extremity may differ from the present findings. Third, although the rolling tempo and application duration were standardized, the amount of pressure applied during SMR was self-regulated by the participants using their own body weight and was not objectively quantified.

This may have resulted in individual differences in the mechanical stimulus applied to the soft tissues. Fourth, this study examined only the acute effects of a single-session SMR application; therefore, the results cannot be extended to repeated or long-term SMR interventions. Finally, no direct measures of range of motion, tissue stiffness, muscle activation, pain perception, or perceived discomfort were collected. As a result, the potential mechanisms underlying the observed performance responses could not be directly examined.

CONCLUSION

The present study demonstrated that acute hamstring-focused deep and superficial SMR protocols did not significantly alter CMJ height, CMJ flight time, or Lane Agility Test performance in male basketball players. These findings suggest that a single-session SMR application to the hamstring muscles, regardless of roller type, does not provide an acute performance-enhancing effect on jump or agility outcomes. Future studies should examine whether SMR applied to multiple lower-limb muscle groups, different application volumes or pressures, and larger or more diverse samples produces different acute responses. Incorporating direct measures of muscle activation, tissue stiffness, and range of motion may also help clarify the physiological and neuromuscular mechanisms underlying SMR-related responses.

Statements & Declarations

Competing Interests The author(s) declare no conflict of interest.

Ethics Approval Ethical clearance for this study was granted by the Research Ethics Committee of Gazi University (Date: April 28, 2026; Decision No: E-77082166-604.01-1527654). All procedures performed in this study involving human participants were conducted in accordance with the ethical standards of the institutional research committee and the 1964 Helsinki Declaration and its later amendments.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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