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ORIGINAL ARTICLE

Acute effects of different foam rolling durations on agility, dynamic balance, and speed in young male soccer players: a randomized crossover design

Genç erkek futbolcularda farklı foam rolling sürelerinin çeviklik, dinamik denge ve sürat üzerine akut etkileri: rastgele bir çapraz tasarım

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Abstract

Purpose: This study aimed to compare the acute effects of different foam rolling (FR) durations on agility, dynamic balance, and speed in young male soccer players.

Methods: Fifteen volunteer young male soccer players (mean age: 16.73±0.44 years) were included in the study, which was planned as an experimental randomized crossover design. All players performed the 3 sessions [FR (1 min), FR (2 min), and FR (3 min)] on separate occasions in a randomized order, with an interval of 7 days. Before and after the interventions, dynamic balance was assessed with the Y balance test, agility was assessed with the agility t-test, and speed was assessed with the 20-m sprint test.

Results: Compared with the pre-test results, significant improvement in dynamic balance (Time (T): $p<0.01$, $F=107.26$, $\eta p^2=0.719$), agility (T: $p<0.01$, $F=52.84$, $\eta p^2=0.557$), and speed (T: $p<0.01$, $F=31.98$, $\eta p^2=0.432$) was observed in all groups. Group × time interaction was not significant for dynamic balance (Group × Time (G x T): $p=0.87$, $F=0.14$, $\eta p^2=0.007$), agility (G × T: $p=0.72$, $F=0.32$, $\eta p^2=0.015$), and speed (G × T: $p=0.23$, $F=1.51$, $\eta p^2=0.067$).

Conclusion: FR training for 1 minute appears to effectively enhance dynamic balance, agility, and speed in young male soccer players. Strength and conditioning coaches should consider integrating this approach into their training programs for optimizing player development.

Keywords: Athletic Performance; Exercise; Football; Myofascial Release; Sport.

Öz

Amaç: *Bu çalışma, genç erkek futbolcularda farklı foam rolling (FR) sürelerinin performans ile ilişkili fiziksel uygunluk parametreleri üzerindeki akut etkilerini karşılaştırmayı amaçladı.*

Yöntem: *Deneysel bir rastgeleleştirilmiş çapraz tasarım şeklinde planlanan bu çalışmaya 15 gönüllü genç erkek futbolcu (ortalama yaş 16,73±0,44 yıl) dâhil edildi. Tüm oyuncular 3 ayrı seansı [FR (1 dk), FR (2 dk) ve FR (3 dk)] rastgele bir sırayla 7 gün arayla gerçekleştirdiler. Müdahale öncesi ve sonrasında dinamik denge Y denge testi ile, çeviklik çeviklik t testi ile, sürat ise 20 m sprint testi ile değerlendirildi.*

Bulgular: *Ön test sonuçlarıyla karşılaştırıldığında, tüm gruplarda dinamik dengede (Zaman (T): $p<0,01$, $F=107,26$, $\square p2=0,719$), çeviklikte (T: $p<0,01$, $F=52,84$, $\square p2=0,557$) ve süratte (T: $p<0,01$, $F=31,98$, $\square p2=0,432$) anlamlı iyileşme gözlendi. Dinamik denge (Grup x Zaman (GxT): $p=0,87$, $F=0,14$, $\square p2=0,007$), çeviklik (GxT: $p=0,72$, $F=0,32$, $\square p2=0,015$) ve sürat (GxT: $p=0,23$, $F=1,51$, $\square p2=0,067$) açısından grup x zaman etkileşimi anlamlı değildi.*

Sonuç: *1 dakikalik FR antrenmanının, genç erkek futbolcularda dinamik denge, çeviklik ve sürat gibi performansa bağlı fiziksel uygunluk parametrelerini etkili bir şekilde geliştirdiği görülüyor. Güç ve kondisyon antrenörleri, oyuncu gelişimini optimize etmek için bu yaklaşımı antrenman programlarına entegre etmeyi düşünmelidir.*

Anahtar Kelimeler: *Atletik Performans; Egzersiz; Futbol; Miyofasyal Gevşetme; Spor.*

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INTRODUCTION

Foam Rolling (FR) has emerged as a highly popular self-myofascial release (SMR) tool, believed to mimic the effects of myofascial release (MR).[1] It has rapidly gained popularity among both elite and recreational athletes.[2] However, despite its widespread use, there is no consensus on its physical and physiological benefits.[3] This may be attributed to the limited research investigating the underlying physiological mechanisms of FR.[4] Proposed physiological mechanisms include increased blood flow, parasympathetic nerve system activation, inflammatory responses, and the break down of trigger-points.[5] Furthermore, mechanical mechanisms encompass several sub-mechanisms, including a reduction in tissue adhesions, altered tissue stiffness, and thixotropic responses.[6] Due to these potential underlying physiological and mechanical mechanisms, FR is believed to enhance dynamic balance, agility, speed, and acute athletic performance.[7]

Dynamic balance, a parameter of performance-related physical fitness, is the ability of an individual to maintain stability of the center of mass during movement. Dynamic balance tests are valuable in detecting potential lower-limb asymmetries, which can increase the risk of injury, particularly in team sports like soccer, where unilateral movements are frequent.[8] Agility, another parameter of performance-related physical fitness, is the capacity to change directions quickly and involves perceptual and decision-making factors.[9] In field sports such as soccer, agility is a crucial performance determinant and plays a role in sports injuries.[10] Lastly, speed is another performance-related physical fitness parameter, similar to dynamic balance and agility. Furthermore, speeding is the most frequent action preceding goals, both for scoring and assisting players in soccer.[11]

Current literature investigating the acute effects of FR on health- or performance-related physical fitness parameters is still emerging.[12] However, FR protocols used throughout the literature are quite diverse with no clear consensus regarding the most efficacious duration.[13] Previous studies have reported similar conclusions that further studies are needed to determine the optimal FR duration.[14,15] It appears that the acute effects of FR periods of 1 to 3 minutes on health- or performance-related physical fitness parameters are generally tested in the current literature.[14,15] Therefore, the present study aimed to compare the acute effects of different FR durations [FR (1 min), FR (2 min), and FR (3 min)] on dynamic balance, agility, and speed in young male soccer players. Also, we hypothesized that there would be a difference between the acute effects of different FR durations on dynamic balance, agility, and speed in young male soccer players.

METHODS

Experimental approach to the problem

An experimental randomized crossover design was conducted to compare the acute effects of different FR durations on dynamic balance, agility, and speed in young male soccer players. Before the experimental sessions, each player underwent a one-day of familiarization with FR intervention. Each player performed the following 3 experimental conditions in a randomized order: FR (1 min), FR (2 min), and FR (3 min) interventions. A 7-day washout period was implemented between experimental sessions. Players were instructed to avoid strenuous training and competition 24 hours prior to each experimental session. The study was conducted during the competition period.

Participants

There were 232 licensed soccer players, including all age groups, in the soccer club where the study was conducted. Due to the intense training and match schedule of other categories soccer players in the club, it was decided to conduct the study on soccer players (n=22) in the club's U-17 category. All available players in the U-17 category were selected to participate in the study. Inclusion criteria included no history of musculoskeletal injury involving the lower extremities. Players with a history of major sports injury or time-loss injury that required surgery (n=5), and those who did not volunteer (n=2) were excluded. Fifteen healthy volunteer soccer players (mean age 16.73±0.44 years, 15 males) performed 3 trials; FR (1 min), FR (2 min), and FR (3 min) on separate occasions in a randomized order with

an interval of 7 days. The priori sample size was estimated at 12 with a power of 0.80, and an effect size (ES) of 0.60.[16] The G*Power (version 3.1.9.2, Heinrich Heine University, Düsseldorf, Germany) was used for calculations. Fifteen players were enrolled to increase statistical power.

Ethical considerations

All players were informed about the details of the study protocol, the experiment procedures, and the possible risks and benefits related to the participation. Informed assent was obtained directly from the players before their participation, and informed consent was obtained from their parents. The study protocol was approved by the Izmir Katip Celebi University Non-Interventional Clinical Studies Ethics Committee (Approval number: 327). The principles of the Declaration of Helsinki were adhered to in the treatment of human research participants.

Procedure

Before participation, all players attended an informational session about the study and were familiarized with the procedures, assessment tools, and equipment by a certified physiotherapist. A computer-generated randomized table of numbers was preferred for randomization. The assessor was blinded to group allocation. The statistical analysis was performed by a professional, blinded to the study's aim. All sessions were conducted under the same physical conditions at an indoor gym at the sports club and at the same time of day (between 5:00 PM and 7:00 PM). Furthermore, all players used the same uniforms and shoes provided by the club in all sessions throughout the study. Each player performed the 3 sessions on separate occasions in a randomized order, with an interval of 7 days. All players were guided by the same certified physiotherapist for all FR sessions. During each session, all players performed 10 minutes of light jogging followed by pre-test measures in the following order: dynamic balance (3 times), agility (2 times), and speed tests (2 times). The duration between jogging and pre-test measures was approximately 5 minutes. After the pre-test measures, all players performed FR (1 min), FR (2 min), and FR (3 min) interventions. Post-test measures were performed in the same order as the pre-test measures approximately 5 minutes after the interventions (Figure 1).

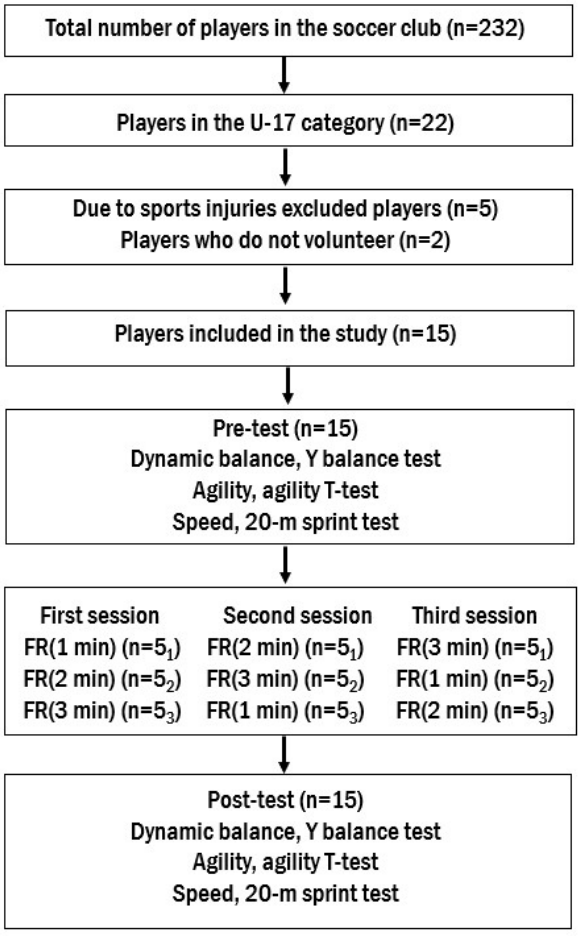

Figure 1. Flowchart of the study.

Primary outcome measure

Dynamic Balance

Dynamic balance was assessed using the Y balance test, a valid and reliable method developed as a version of the star excursion balance test.[17] During test preparation, 3 tape measures were positioned at 135° between the anterior direction and the posterolateral/posteromedial directions. Players were instructed to maintain balance on their dominant leg at the junction of the tapes while reaching as far as possible with the non-dominant leg in three directions, namely anterior, posterolateral, and posteromedial. Measurements were taken 3 times for the dominant side, and the average of the endpoints reached by the players was used for data analysis. Leg dominance was determined by

asking players, "If you were to shoot a ball at a target, which leg would you use to shoot the ball?" During reaches to different sides, the players' stable feet remained stationary, and their feet were placed completely on the junction of the tapes. Reach distances were normalized to limb length by calculating the maximized reach distance (in percentage of maximized reach distance) using the formula: (excursion distance/limb length) × 100 = percentage of maximized reach distance.[18] The composite score was calculated by summing the 3 reach directions, dividing by 3 times the limb length, and then multiplying by 100. The mean value for the Y balance composite score was used for data analysis.

Secondary outcome measures

Agility

Agility was assessed using the agility t-test, a valid and reliable method used in the assessment of agility performance.[19] For this test, an agility circuit was created using 4 cones named a, b, c, and d. Cones were also set up at a distance of 10 yards between a and b, and 5 yards between b and c, and b and d. At the "go" command, the players sprinted forward from cone a to cone b, sidestepped to cone c, sidestepped to cone d, sidestepped to cone b, then backpedal as fast as possible to cone a. The test was conducted with timing gates (SmartSpeed System, Fusion Sport, Brisbane, Australia) positioned to the right and left of a cone. The test was performed 2 times with at least 2-minute rest periods between trials. The best score of the 2 trials was used for data analysis.[20]

Speed

Speed was assessed using the 20-m sprint test, a valid and reliable method used in studies to evaluate speed.[21] During the test, at the "go" command, the players were instructed to complete the 20-meter distance as quickly as possible, and timing gates (SmartSpeed System, Fusion Sport, Brisbane, Australia) were used to determine the time to complete the test. All players performed the test 2 times with at least 2-minute rest periods between trials. The best score of the 2 trials was used for data analysis.[20]

Foam Rolling Interventions

FR was performed using a foam roller (The Grid Foam Roller, Trigger Point Technologies, Austin, TX, USA). Before the experimental sessions, all players performed a familiarization session on the correct FR technique. Players actively rolled back and forth between the origin and insertion of the target muscles, applying their body weight as much as possible for 1, 2 and 3 minutes. In all conditions, players performed foam rolling for each muscle group interspersed with 30 seconds of rest between sets. Rolling frequency was standardized using a metronome set at 60 beats per minute. Subjects were instructed to roll at a velocity of 2 metronome beats for each rolling direction. Intensity of pressure was controlled with a target rating of 7 out of 10 on a Numerical Rating Scale (0 = no discomfort and 10 = maximum discomfort) during FR interventions.[22] The target muscle groups were the bilateral anterior thigh, posterior thigh, gluteals (buttocks), and posterior calf (Figure 2).

Statistical analysis

Statistical analyses were performed using the statistical package program IBM SPSS Statistics Standard Concurrent User V 26 (IBM., Armonk, New York, USA). Descriptive data were reported as mean ± SD. The normal distribution of the data was confirmed using the Shapiro-Wilk test. Differences in all variables at the pre-test assessments between the FR (1 min), FR (2 min), and FR (3 min) interventions were determined using one-way analysis of variance (ANOVA). A two-way repeated-measures ANOVA using two factors (test time: pre-test vs. post-test) and (conditions: FR (1 min) vs. FR (2 min) vs. FR (3 min)) was used to analyze the interaction and main effects for all the variables. Classification of effect size (ES) was set where $\eta p^2 < 0.01$ was considered small, 0.02 - 0.1 was considered medium, and more than 0.1 was considered to be a large effect size.[23] If the interaction or main effect was significant, a post-hoc analysis was conducted using a paired t-test with Bonferroni correction on each group to determine differences between pre-test and post-test values. Additionally, ES was calculated ($d = M1 - M2 / \sigma pooled$) for each group. ES values in the range of 0.00-0.19 were considered trivial, and values in the ranges of 0.20-0.49, 0.50-0.79, and ≥0.80 were considered small, moderate, and large, respectively.[23] The significance level (α) was set at 0.05.

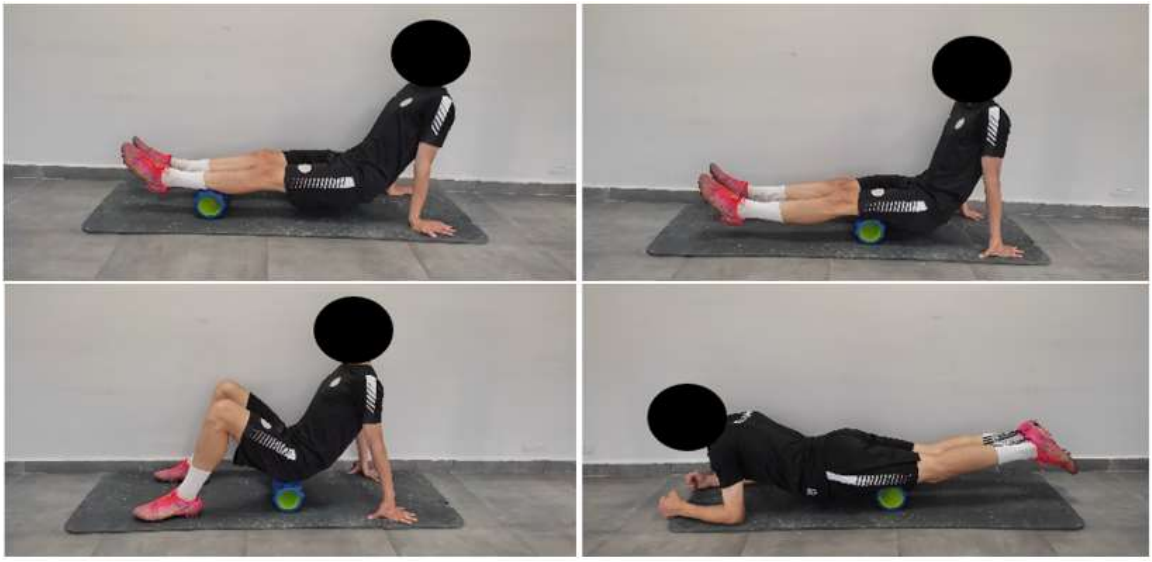

Figure 2. Foam rolling performed in the study.

RESULTS

Players' characteristics are presented in Table 1. The one-way ANOVA showed no differences in pre-test values between FR (1 min), FR (2 min), and FR (3 min) groups, presented in Table 2. There were main effects for time for dynamic balance (Time (T): $p<0.01$, $F=107.26$, $\eta p^2=0.719$), agility (T: $p<0.01$, $F=52.84$, $\eta p^2=0.557$), and speed (T: $p<0.01$, $F=31.98$, $\eta p^2=0.432$). Accordingly, dynamic balance, agility, and speed improved in all conditions [FR (1 min), FR (2 min), and FR (3 min)] (Table 2 and Figure 3).

Table 1. Players' characteristics (N=15).

	Mean±SD
Age (year)	16.73±0.44
Height (cm)	177.86±6.04
Weight (kg)	68.66±6.41
Body mass index (kg/m^2)	21.70±1.37
Soccer experience (year)	7.93±1.25

The two-way repeated-measures ANOVA indicated no significant interactions for dynamic balance (Group x Time (G×T): $p=0.87$, $F=0.14$, $\eta p^2=0.007$), agility (G×T: $p=0.72$, $F=0.32$, $\eta p^2=0.015$), and speed (G×T: $p=0.23$, $F=1.51$, $\eta p^2=0.067$). Accordingly, the improvement in dynamic balance, agility, and speed were similar in all conditions [FR (1 min), FR (2 min), and FR (3 min)] (Table 2 and Figure 3).

DISCUSSION

The present study aimed to compare the acute effects of different durations of FR on dynamic balance, agility, and speed in young male soccer players. The main findings revealed that 1, 2, and 3 minutes of FR significantly improved dynamic balance, agility, and speed. Additionally, the positive effects of different FR durations on dynamic balance, agility, and speed were similar.

Current literature investigating the effects of different FR durations on performance-related physical fitness parameters in various populations is still emerging.[24-26] One of the performance-related physical fitness parameters is dynamic balance, a key determinant of performance in sports and is associated with agility and speed.[27] Therefore, the change in dynamic balance was the primary interest of the present study. Similar results have been observed in previous studies

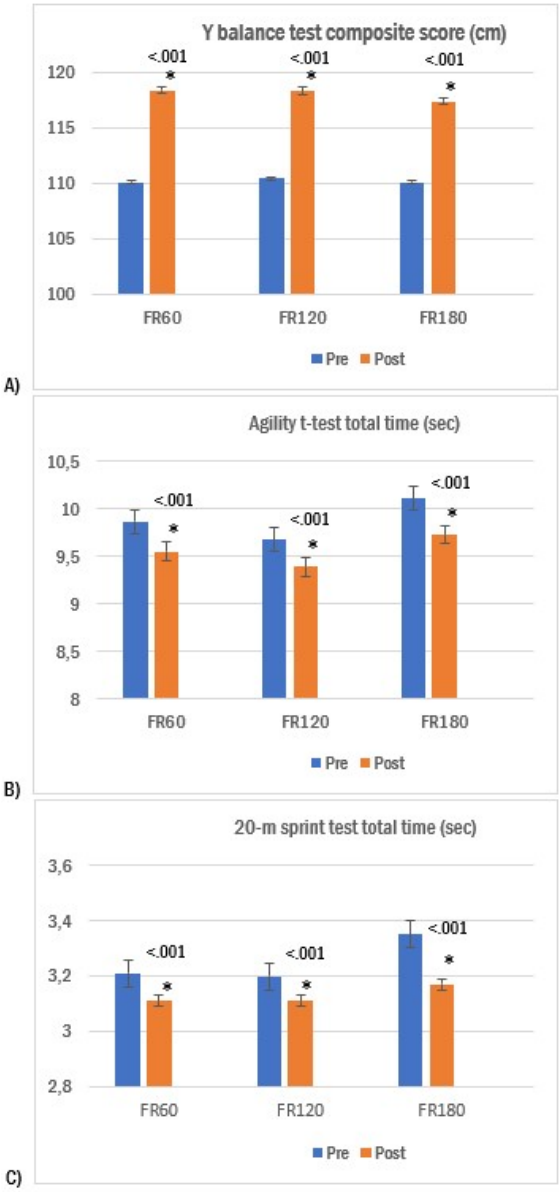

Figure 3. Comparison of (mean ± SD) Y balance test composite score (A), agility t-test total time (B), and 20-m sprint test total time (C) changes from pre-test to post-test measurements within and between the groups. "*" indicates the difference from pre-test to post-test measurements within the group.

investigating the acute effects of FR on dynamic balance. Accordingly, De Benito et al.[24] reported the positive effects of FR applied for 2 minutes on dynamic balance in healthy recreationally active participants. Lee et al.[25] found that FR applied for 90 seconds improved dynamic balance in young adults. Furthermore, Dadfar et al.[26] showed that FR applied for 3 minutes improved dynamic balance in recreationally active females. Similarly to the current literature, the results of the present study revealed the positive effects of FR on dynamic balance in young male soccer players. Moreover, according to the present study, FR applied for 1 minute is sufficient to improve dynamic balance. Considering the results of studies in the current literature, the positive effects of the FR on balance can be explained by different mechanisms, even when applied with different durations or protocols. Firstly, mechanical pressure on soft tissues during FR stimulates mechanoreceptors and increases proprioceptive input.[28] Another explanation is that FR improves the perception of stability in the knee and ankle joints.[24]

On the other hand, agility and speed were the secondary interest of the present study. Agility, like balance, is a crucial determinant of high-level performance in sports. Therefore, agility is also included in studies examining the acute effects of FR on performance determinants in sports.[29-32] Accordingly, some studies have reported that FR applied for 1 minute is effective in increasing agility on different subjects.[29-31] However, Henning et al.[32] reported that FR applied for 1 minute did not improve the agility in recreationally active subjects. Contrary to the positive effects reported in the literature, they stated that these results may be due to the different types of subjects used. Considering the results of the studies in the literature, it was seen that FR applied for at least 1 minute may be sufficient duration to increase agility. Similarly, as a result of the present study, it was concluded that the FR applied for 1 minute was sufficient to increase agility. These results can be explained by an increase in arterial blood flow and tissue perfusion.[33] In other words, these peripheral changes may have a positive effect on muscle performance. Furthermore, the improvement in dynamic balance may have positively affected agility.

Lastly, speed is also one of the parameters of performance-related physical fitness and a determinant for high-level performance in sports, like dynamic balance and agility.

Table 2. Changes in dynamic balance, agility, and speed before (Pre-test) and after (Post-test) FR (1 min), FR (2 min), and FR (3 min) interventions.

	FR (1 min) (n=15)		FR (2 min) (n=15)		FR (3 min) (n=15)	
	Pre-test Mean±SD	Post-test Mean±SD	Pre-test Mean±SD	Post-test Mean±SD	Pre-test Mean±SD	Post-test Mean±SD
Dynamic balance (cm)	110.12±11.48	118.39±12.05* *d*= 0.70	110.45±11.00	118.30±10.22* *d*= 0.73	110.09±8.49	117.39±7.78* *d*= 0.89
Agility (sec)	9.87±0.45	9.55±0.44* *d*= 0.71	9.68±0.40	9.39±0.34* *d*= 0.78	10.11±0.44	9.73±0.42* *d*= 0.88
Speed (sec)	3.21±0.24	3.11±0.20* *d*= 0.45	3.20±0.11	3.11±0.11* *d*= 0.81	3.35±0.27	3.17±0.24* *d*= 0.70
	ANOVA results p value, F value, $\square p^2$					
Dynamic balance (cm)	T: $p < 0.01$, $F = 107.26$, $\square p^2 = 0.719$, G × T: $p = 0.87$, $F = 0.14$, $\square p^2 = 0.007$					
Agility (sec)	T: $p < 0.01$, $F = 52.84$, $\square p^2 = 0.557$, G × T: $p = 0.72$, $F = 0.32$, $\square p^2 = 0.015$					
Speed (sec)	T: $p < 0.01$, $F = 31.98$, $\square p^2 = 0.432$, G × T: $p = 0.23$, $F = 1.51$, $\square p^2 = 0.067$					

* $p<0.05$, diference from the Pre-test values. FR(1 min): Foam rolling applied for 1 minute. FR(2 min): Foam rolling applied for 2 minutes. FR(3 min): Foam rolling applied for 3 minutes. ANOVA: Analysis of variance. d: Cohen's d. T: time. G: group. G x T: group x time. The two-way ANOVA results (T: time effect, G x T: group x time interaction effect; F-value) and partial $\square^2$ ($\square p^2$) are shown in right column.

However, different results are reported in previous studies examining the acute effects of FR on speed in the literature. Accordingly, Kaya et al.[34] reported that FR applied for 45 seconds improved speed in male soccer players. Conversely, Lopez-Samanes et al.[29] showed that FR applied for 1 minute did not improve speed in elite tennis players. Similarly, Pelana et al.[31] reported that FR applied for 1 minute did not improve speed in elite futsal players. Also, Klich et al.[35] found that FR applied for 90 seconds improved speed in academic athletes. The reason for the differences in the results of the studies may be the application of different protocols and the preference of different populations. As a result of the present study, it was concluded that the FR applied for 1 minute was sufficient to increase speed, like dynamic balance and agility. These results can be explained by similar mechanisms described above. Other possible mechanisms are that FR reduces myofascial and arterial stiffness, increases vascular endothelial functions, and changes the viscoelastic and thixotropic properties of fascia.[36] Additionally, the improvement in dynamic balance may have positively affected speed as well as agility. Interestingly, in the present study, it was observed that applying the FR method for a longer period did not provide additional benefits to dynamic balance, agility, and speed. This result can be explained by the fatigue due to possible insufficient strength and endurance of the upper extremity and core region muscles that occurs during long-term FR in players and the reflection of this fatigue on performance.

Limitations

The present study had some limitations. The present study did not include a control group. Therefore, the lack of comparative analysis of the results obtained with the control group is an important limitation of the study. The present study was conducted on young male soccer players. Performance-related physical fitness parameters may worsen with age due to adverse physiological changes. This may affect the results obtained from the studies. Therefore, these results cannot be generalized to all age groups of soccer players. Although the intensity of pressure is controlled by the Numerical Rating Scale, pressure exerted during FR interventions may vary due to differences in the player's body weight. This difference may have affected the effect of FR and the results obtained. Similarly, possible differences in the pain threshold of players may have prevented the standardization of the application dose of FR.

Conclusion

FR training for 1 minute appears to effectively enhance dynamic balance, agility, and speed in young male soccer players. Strength and conditioning coaches should consider integrating this approach into their training programs for optimizing player development.

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Authors' Contributions: **ES:** Concept/Idea Development, Study Design, Data Collection/Processing, Data Analysis/Interpretation, Literature Search, Provision of Facts, Provision of Facilities/Equipment, Writing; **SGU:** Concept/Idea Development, Study Design, Literature Search, Provision of Case, Provision of Facilities/Equipment, Critical Review; **DÖK:** Concept/Idea Development, Study Design, Literature Search, Provision of Case, Provision of Facilities/Equipment, Critical Review.

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Ethical Approval: The study protocol was approved by the Izmir Katip Celebi University Non-Interventional Clinical Studies Ethics Committee (Approval number: 327).

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