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Erkeklere Uygulanan Dinamik Esneme ve Foam Roller Uygulamalarının Statik ve Dinamik Denge Üzerindeki Akut Etkileri

Sedat ÖZCAN[1], Halil GÜNGÖR[2], Ali SAÇIKARA[3], Muhammed Berk SAVGA[4], Doğukan Hakan ATÇEKEN[5], Elif TAŞKUYU[6*]

[1]Faculty of Sport Sciences, Suleyman Demirel University, 32200 Isparta, Turkey: sedatozcan@sdu.edu.tr https://orcid.org/0000-0002-0428-3883

[2]Faculty of Sport Sciences, Selcuk University, 42100 Konya, Turkey. halilgungor88@gmail.com. https://orcid.org/0000-0002-8133-7777

[3]Faculty of Sport Sciences, Selcuk University, 42100 Konya, Turkey. byali.sacikara@gmail.com https://orcid.org/0009-0004-3504-422X

[4]Faculty of Sport Sciences, Selcuk University, 42100 Konya, Turkey. b.savga898898@gmail.com https://orcid.org/0009-0006-3536-3057

[5]Faculty of Sport Sciences, Selcuk University, 42100 Konya, Turkey. dogukanhakan@hotmail.com https://orcid.org/0009-0006-3536-3057

[6*]Faculty of Sport Sciences, Akdeniz University, 07050 Antalya, Turkey. elif.taskuyu@hotmail.com https://orcid.org/0000-0002-9724-9149

Özet

Denge, sportif performans ve yaralanmaların önlenmesinde kritik bir rol oynamaktadır. Ancak, yaygın olarak uygulanan ısınma tekniklerinin denge üzerindeki akut etkileri hâlâ netlik kazanmamıştır. Dinamik esnetme ve foam rolling uygulamaları, esnekliği artırmak ve nöromüsküler hazırlığı desteklemek amacıyla sıklıkla tercih edilmekte, ancak bu yöntemlerin denge performansına olan doğrudan etkileri tartışmalıdır. Bu araştırmanın amacı, dinamik esnetme ve foam rolling protokollerinin rekreasyonel düzeyde aktif erkek bireylerde statik ve dinamik denge performansı üzerindeki akut etkilerini karşılaştırmalı olarak incelemektir. Çalışmaya, Selçuk Üniversitesi'nden gönüllü olarak katılan, yaş ortalaması 21,42 ± 1,55 yıl, boy ortalaması 178,26 ± 6,28 cm ve vücut ağırlığı ortalaması 71,66 ± 7,42 kg olan toplam 50 fiziksel olarak aktif erkek birey dahil edilmiştir. Katılımcıların tamamı herhangi bir denge bozukluğu, kas-iskelet sistemi yaralanması veya kronik rahatsızlığı bulunmayan bireylerden seçilmiştir. Araştırma, randomize çapraz (crossover) tekrar ölçümlü bir tasarım ile yürütülmüştür. Katılımcılar her iki protokolü de (dinamik esnetme ve foam rolling) farklı günlerde, en az 48 saatlik dinlenme süresi bırakılarak uygulamış ve ardından denge testlerine tabi tutulmuştur. Her bir protokol 3 dakika sürmüş olup, triseps surae, hamstring ve kuadriseps kas gruplarını hedeflemiştir. Denge ölçümleri, Biodex Balance System kullanılarak hem statik (gözler kapalı) hem de dinamik (gözler açık) koşullarda gerçekleştirilmiştir. Ölçülen parametreler arasında Genel Stabilite İndeksi (OSI), Anterior-Posterior Stabilite İndeksi (APSI) ve Medial-Lateral Stabilite İndeksi (MLSI) yer almaktadır. Ölçümler dominant bacak üzerinde, tek ayak duruş pozisyonunda yapılmıştır. Verilerin karşılaştırılmasında eşleştirilmiş t-testi (paired samples t-test) kullanılmıştır. Dinamik denge ölçümlerine göre, dinamik esnetme sonrasında OSI ortalaması 2,63 ± 0,73, foam rolling sonrası ise 2,54 ± 0,68 olarak bulunmuştur. Anterior-posterior indeksi sırasıyla 1,74 ± 0,60 (DE) ve 1,69 ± 0,62 (FR), medial-lateral indeksi ise 1,55 ± 0,45 (DE) ve 1,51 ± 0,41 (FR) olarak ölçülmüştür. İstatistiksel analizlerde dinamik dengeye dair hiçbir parametrede anlamlı fark saptanmamıştır ($p > 0,05$). Etki büyüklükleri küçük düzeyde kalmış ve 0,09 ile 0,21 arasında değişmiştir. Statik denge performansında ise dinamik esnetme sonrası OSI değeri 2,96 ± 0,73, foam rolling sonrası ise 2,97 ± 0,75 olarak ölçülmüştür. Anterior-posterior indeksi dinamik esnetme için 2,03 ± 0,65 ve foam rolling için 2,12 ± 0,70 olarak kaydedilmiştir. Medial-lateral değerler ise sırasıyla 1,66 ± 0,40 (DE) ve 1,60 ± 0,49 (FR) olarak bulunmuştur. Bu test sonuçlarında da gruplar arasında anlamlı bir fark bulunmamış, tüm p değerleri 0,05'in üzerinde kalmıştır. Cohen's d etki büyüklükleri bu ölçümler için de çok küçük olup 0,03 ile 0,19 arasında değişmiştir. Sonuç olarak, çalışmada hem dinamik esnetme hem de foam rolling uygulamaları, kısa süreli (akut) etki açısından değerlendirildiğinde, rekreasyonel olarak aktif erkek bireylerin statik ve dinamik denge performansları üzerinde anlamlı bir değişiklik oluşturmamıştır. Dinamik esnetme uygulamasının dinamik denge parametrelerinde istatistiksel olarak anlamlı olmamakla birlikte küçük çaplı bir iyileşme eğilimi gözlenmiştir. Bu bulgular, kısa süreli ısınma uygulamalarının denge üzerindeki etkisinin sınırlı olduğunu ve daha uzun ya da farklı içerikli protokollerin incelenmesi gerektiğini göstermektedir.

Anahtar Kelimeler: Dinamik Esnetme, Foam Rolling, Denge Performansı.

İletişim: Elif Taşkuyu, Akdeniz Üniversitesi Spor Bilimleri Fakültesi, elif.taskuyu@hotmail.com

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Acute Effects Of Dynamic Stretchıng and Foam Roller Applications Applied To Men On Static and Dynamic Balance

Abstract

Balance plays a critical role in sports performance and injury prevention. However, the acute effects of commonly applied warm-up techniques on balance have not yet been clearly established. Dynamic stretching and foam rolling practices are frequently preferred to improve flexibility and support neuromuscular readiness, yet the direct effects of these methods on balance performance remain debatable. The aim of this study is to comparatively examine the acute effects of dynamic stretching and foam rolling protocols on static and dynamic balance performance in recreationally active male individuals. The study included a total of 50 physically active male participants who voluntarily took part from Selçuk University, with a mean age of 21.42 ± 1.55 years, a mean height of 178.26 ± 6.28 cm, and a mean body weight of 71.66 ± 7.42 kg. All participants were free from any balance disorders, musculoskeletal injuries, or chronic medical conditions. The study was conducted using a randomized crossover repeated-measures design. Each participant performed both protocols (dynamic stretching and foam rolling) on separate days, with at least 48 hours of rest between sessions, and subsequently underwent balance tests. Each protocol lasted for 3 minutes and targeted the triceps surae, hamstrings, and quadriceps muscle groups. Balance measurements were performed using the Biodex Balance System under both static (eyes closed) and dynamic (eyes open) conditions. The measured parameters included the Overall Stability Index (OSI), Anterior-Posterior Stability Index (APSI), and Medial-Lateral Stability Index (MLSI). All measurements were conducted in a single-leg stance on the dominant leg. Paired samples t-tests were used for data comparison. According to the dynamic balance measurements, the OSI following dynamic stretching was 2.63 ± 0.73, while it was 2.54 ± 0.68 after foam rolling. The anterior-posterior index was measured as 1.74 ± 0.60 (DS) and 1.69 ± 0.62 (FR), and the medial-lateral index as 1.55 ± 0.45 (DS) and 1.51 ± 0.41 (FR). Statistical analysis revealed no significant differences in any of the dynamic balance parameters ($p>0.05$). Effect sizes were small, ranging between 0.09 and 0.21. Regarding static balance performance, the OSI was measured as 2.96 ± 0.73 following dynamic stretching and 2.97 ± 0.75 after foam rolling. The anterior-posterior index was recorded as 2.03 ± 0.65 (DS) and 2.12 ± 0.70 (FR). Medial-lateral values were found to be 1.66 ± 0.40 (DS) and 1.60 ± 0.49 (FR), respectively. These test results also indicated no significant differences between the groups, with all p-values above 0.05. Cohen's d effect sizes for these measurements were also very small, ranging between 0.03 and 0.19. In conclusion, when evaluated in terms of short-term (acute) effects, both dynamic stretching and foam rolling protocols did not lead to significant changes in static and dynamic balance performance among recreationally active male individuals. Although not statistically significant, a slight improvement trend was observed in the dynamic balance parameters following dynamic stretching. These findings indicate that the effects of short-term warm-up practices on balance are limited and that longer or differently structured protocols should be examined.

Keywords: Dynamic Stretching, Foam Rolling, Balance Performance.

Introduction

The warm-up is a standard component of pre-exercise routines, designed to prepare the body for physical activity, enhance performance, and reduce the risk of injury. Flexibility-based exercises are often integrated into warm-ups to improve range of motion (ROM), with dynamic stretching (DS) being a particularly common method. DS has been shown to acutely enhance ROM and, in some studies, improve balance performance as well (David George Behm et al., 2016; Chatzopoulos, Galazoulas, Patikas, & Kotzamanidis, 2014; Kurt & Fırtın, 2016; Smith, Pridgeon, & Hall, 2018).

However, findings regarding the effects of DS on dynamic balance remain inconsistent. While several studies report moderate to significant improvements in dynamic balance following DS, others show only slight or negligible effects (Lohmann et al., 2024). These discrepancies may be attributed to moderating variables such as age, gender, training history, or the intensity and duration of stretching protocols. For instance, dynamic stretching has shown positive outcomes on balance in older adults (Narducci, 2017) and appears not to impair balance in active middle-aged individuals (Belkhiria-Turki et al., 2014) .In contrast(Wallmann, Player, & Bugnet, 2012) reported minimal impact of DS on dynamic balance among both young and elderly participants, possibly due to the short duration and low intensity of the interventions used. It is well-documented that the intensity and duration of stretching exercises are crucial determinants of their effectiveness (Zhou, Lin, Chen, & Chien, 2019). Consequently, while DS is generally believed to improve performance through mechanisms such as elevated muscle and core temperature, post-activation potentiation (PAP), enhanced neuromuscular activation, and reduced antagonist muscle inhibition (Kurt & Fırtın, 2016), its direct influence on dynamic balance has yet to be definitively established in the literature.

In recent years, foam rolling (FR) a self-myofascial release technique—has gained popularity as an alternative or complement to traditional stretching methods. Typically performed by placing a dense foam roller under targeted muscles and applying body weight while rolling back and forth, FR is thought to reduce myofascial tension and improve soft tissue mobility. Although its exact mechanism remains under investigation, one prevailing theory suggests that the mechanical pressure applied during FR helps break down fascial adhesions and improve tissue pliability (Behara & Jacobson, 2017). Several studies have reported acute improvements in ROM following foam rolling, similar to those observed after dynamic stretching. Moreover, FR may offer the advantage of enhancing flexibility without compromising muscle strength, making it a potentially effective warm-up modality (Su, Chang, Wu, Guo, & Chu, 2017). However, its impact on performance outcomes such as static and dynamic balance remains unclear. Some models and empirical findings argue that foam rolling

may not significantly affect muscle strength or functional measures like dynamic balance (Behara & Jacobson, 2017; Smith et al., 2018).

Given these contrasting findings, the acute effects of dynamic stretching and foam rolling on balance-related performance remain a subject of debate. To address this gap, the present study investigates the acute effects of dynamic stretching and foam rolling on static and dynamic balance in healthy male participants. The results aim to inform evidence-based practices in warm-up design, particularly in contexts where balance performance is critical.

Materials and Methods

Subjects

Fifty recreationally active male participants from Selçuk University voluntarily took part in this study. The participants had a mean age of 21.42 ± 1.55 years, a mean height of 178.26 ± 6.28 cm, and a mean body weight of 71.66 ± 7.42 kg. All participants were non-professional athletes who engaged in physical activity on a recreational basis. Inclusion criteria required participants to be free from any known balance disorders, musculoskeletal injuries, or chronic medical conditions. All participants were informed about the study's objectives and potential risks. The study was approved by the local ethics committee (Protocol number 196, 28/05/2025, Ethics Committee of Selcuk University, Faculty of Sports Science, Konya, Turkey). Before the assessment, every participant received the same detailed information about the testing procedure. Every participant signed the informed consent. "Throughout the course of the present study, all procedures were conducted in accordance with the 'Directive on Scientific Research and Publication Ethics of Higher Education Institutions'."

Experimental Design

This study employed a randomized crossover repeated-measures design to examine the acute effects of dynamic stretching and foam rolling on static and dynamic balance performance in recreationally active male participants. Each participant visited the laboratory on three separate occasions, with a minimum of 48 hours between sessions to minimize carryover effects. During the first visit, an orientation and familiarization session was conducted. Participants' height was measured using a stadiometer and body weight was recorded using a digital scale. Both intervention protocols (dynamic stretching and foam rolling) were demonstrated, and participants were allowed to briefly practice each technique to ensure proper execution and standardization. In addition, participants were familiarized with the balance testing procedures by performing trial runs on the Biodex Balance System to minimize learning effects during actual testing. During the second and third visits, each

participant completed one of the two stretching protocols dynamic stretching or foam Rolling in a randomized order. Only one protocol was administered per visit. Immediately after each protocol, participants performed balance assessments using the Biodex Balance System to evaluate static and dynamic balance performance. This design allowed for within-subject comparisons of the acute effects of each intervention.

Dynamic Stretching Protocol

Participants performed dynamic stretching exercises targeting the specified muscle groups. Each movement was performed for 30 seconds on each side, individually. Triceps Surae: Participants stood upright and performed ankle movements to stretch the calf muscles. Hamstrings: The leg was lifted forward with hip flexion and the movement was repeated. Quadriceps: The leg was lifted backward with hip extension. The total duration of the protocol was 3 minutes (Kopec, Bishop, & Esco, 2017).

Foam Rolling Protocol

Foam rolling was performed using a 36-inch high-density roller. Each muscle group was targeted individually. Triceps Surae: Participants placed their calves on the roller and moved back and forth along the muscle. Hamstrings: The roller was positioned under the back of the thigh and rolled along the hamstring muscles. Quadriceps: Participants lay in a prone position and rolled over the front of the thigh muscles. The total duration of the protocol was 3 minutes (Kopec, Bishop, & Esco, 2017).

Balance Test

Dynamic (eyes open) and static (eyes closed) balance performances were assessed using the Biodex Balance System (BBS; Biodex Medical Systems Inc., Shirley, NY, USA). To minimize learning effects, participants performed two familiarization trials prior to testing. The main test was conducted on the dominant leg in a single-leg stance with arms crossed over the chest. For the dynamic balance test, the platform difficulty level was set to Level 5 (Löklüoğlu, Yılmaz, Özcan, & Tatlıcı, 2024), and the test was performed with eyes open. For the static balance test, a fixed platform was used, and participants kept their eyes closed. During both tests, the non-supporting leg remained off the ground, and participants were instructed not to look at the monitor. Three balance indices were recorded: Overall Stability Index (OSI), Anterior-Posterior Stability Index (APSI), and Medial-Lateral Stability Index (MLSI). Lower values indicated better balance performance (Taskuyu et al., 2024). The reliability of the balance assessment protocol was supported by previous validation studies, which demonstrated high test–retest reliability of the Biodex Balance System among physically active populations (Cachupe, Shifflett, Kahanov, & Wughalter, 2001).

Statistical Analysis

All statistical analyses were performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). The normality of the data was assessed using the Shapiro-Wilk test, and all balance parameters were found to be normally distributed. This was further supported by skewness and kurtosis values falling within the acceptable range of –1.5 to +1.5. To compare the effects of the two stretching protocols (Foam Roller vs. Dynamic Stretching) on balance performance, paired samples t-tests were conducted separately for each balance parameter (Overall Index, Anterior-Posterior, and Medial-Lateral) under both static and dynamic balance conditions. The level of statistical significance was set at $p<.05$ for all comparisons. In addition, effect sizes were calculated using Cohen's d, where values of 0.2, 0.5, and 0.8 represent small, medium, and large effects, respectively (Cohen. 1988). Descriptive statistics including means, standard deviations, t-values, p-values, and 95% confidence intervals were reported for all relevant variables.

Findings

Table 1. Descriptive Statistics of Participants

Parameters	N	Minimum	Maximum	Mean	Std. Deviation
Age	50	18	25	21,42	1,55
Height	50	168	190	178,26	6,27
Body Weight	50	60	89	71,66	7,42

Table 2. Comparison of Dynamic Balance Parameters Following Dynamic Stretching and Foam Roller Stretching

Parameters	**Mean**	**Std. Deviation**	**t**	**95% Confidence Interval of the Difference**		**p**	**E.S**
				Lower	**Upper**		
Dynamic overall	2,63	,73	1,500	-,0298	,2058	,140	0,21
Foam overall	2,54	,68					
Dynamic ant-post	1,74	,60	,800	-,0755	,1755	,427	0,11
Foam ant-post	1,69	,62					
Dynamic med-lat	1,55	,45	,660	-,0817	,1617	,512	0,09
Foam med-lat	1,51	,41					

Overall: Overall Stability Index; ant-post: Anterior-Posterior Stability Index; med-lat: Medio-Lateral Stability Index

According to the findings, participants' dynamic balance performance was found to be similar following both dynamic stretching and foam roller stretching. No statistically significant differences were observed in the overall balance score, as well as in the anteroposterior (front-back) and mediolateral (side-to-side) balance parameters after the interventions ($p>0.05$).

Table 3. Comparison of Static Balance Parameters Following Dynamic Stretching and Foam Roller Stretching

Parameters	Mean	Std. Deviation	t	95% Confidence Interval of the Difference		p	E.S
				Lower	Upper		
Dynamic overall	2,96	,73	-,191	-,1154	,0954	,850	0,03
Foam overall	2,97	,75					
Dynamic ant-post	2,03	,65	-1,325	-,2114	,0434	,191	0,19
Foam ant-post	2,12	,70					
Dynamic med-lat	1,66	,40	1,175	-,0440	,1680	,246	0,17
Foam med-lat	1,60	,49					

Overall: Overall Stability Index; ant-post: Anterior-Posterior Stability Index; med-lat: Medio-Lateral Stability Index

The results indicated that static balance performance was comparable following both dynamic stretching and foam roller interventions. No statistically significant differences were identified in the overall balance score or in the anteroposterior (front-back) and mediolateral (side-to-side) static balance parameters after the applications ($p>0.05$).

Discussion

The primary aim of this study was to examine the acute effects of dynamic stretching, and foam rolling on dynamic balance in physically active males. The results indicated that none of the two conditions foam Rolling or dynamic stretching led to statistically significant improvements in dynamic balance, as measured by Biodex Balance System (the Overall Stability Index, Anterior-Posterior Stability Index, and Medial-Lateral Stability Index). These findings are in line with much of the existing literature, which suggests that foam and dynamic stretching may have minimal effects on dynamic balance performance (David G Behm & Chaouachi, 2011).

Static stretching is frequently used to enhance range of motion (ROM) both in the short term and over longer periods. However, when applied immediately before physical activity, it has been linked to temporary decreases in power output and force generation (Chatzopoulos et al., 2014). Conversely, dynamic stretching does not appear to produce these negative effects. Research by Fletcher and Jones (2004) demonstrated that incorporating static stretching into a warm-up routine may reduce performance in short sprints, whereas dynamic stretching can improve performance in 20-meter sprints. The reduction in sprint ability following static stretching is thought to result from increased compliance of the musculotendinous unit (MTU), which diminishes its capacity to store elastic energy during eccentric muscle actions. Moreover, Manoel, Harris-Love, Danoff, and Miller (2008) observed that dynamic stretching can acutely enhance muscular power more effectively than static or proprioceptive neuromuscular facilitation (PNF) stretching in recreationally active females. Although balance is not commonly regarded as a direct measure of performance like strength or speed, it

remains an essential aspect of physical fitness and athletic readiness. Limited research suggests that certain types of dynamic stretching may either improve or have no effect on dynamic flexibility, potentially influencing balance. The inconsistencies in results across studies are likely due to methodological differences, such as variations in stretch duration, intensity, participant characteristics, and testing protocols. A recent meta-analysis by Lohmann et al. (2024) emphasized that both the duration and intensity of stretching protocols may have a key role in acute effects of stretching on physical performance. In the present study, dynamic stretching was performed at moderate intensity (30 seconds per repetition), which may explain the absence of adverse effects on balance. Conversely, based on the majority of scientific studies involving individuals within the same age range as our study population, the acute effects of flexibility on dynamic balance appear to be negligible or even detrimental. These studies also emphasize that balance is influenced by differences in muscle stiffness and viscoelastic properties between middle-aged adults and university-aged subjects. Given that comparable experimental designs in previous studies have also reported neutral outcomes, the findings of this study align with the broader literature indicating that moderate dynamic stretching exerts minimal effects on dynamic balance (Lohmann et al., 2024).

No significant acute improvements in dynamic balance were observed following foam rolling in the present study. MacDonald et al. (2013) reported a notable increase in knee joint range of motion (ROM) following foam rolling of the quadriceps, with improvements of 12.7% observed at 2 minutes post-intervention and 10.3% at 10 minutes. However, no significant alterations were found in voluntary or evoked muscle function as a result of the foam rolling. To the best of our knowledge, there are no other studies comparing the effects of dynamic stretching and foam rolling on dynamic balance. However, muscle strength and jumping performances, which have previously been reported to be highly correlated with dynamic balance, can also guide us in this regard. Behara and Jacobson (2017) demonstrated that dynamic stretching does not acutely affect muscular strength and power. These results are also consistent with prior research suggesting that self-myofascial release (SMR) techniques, including foam rolling, generally have minimal or no effect on balance performance (Halperin, Aboodarda, Button, Andersen, & Behm, 2014). Although foam rolling is often credited with enhancing proprioceptive feedback and neuromuscular coordination, our findings do not support its effectiveness in improving balance as a standalone method. This may be explained by the fact that proprioceptive receptors such as mechanoreceptors, Golgi tendon organs, and muscle spindles are most responsive to active movement, not passive modalities like foam rolling (Amrinder, Deepinder, & Singh, 2012). Nonetheless, a limited number of studies have suggested potential benefits of foam rolling on balance. For example, Shim, Melton, Fiaud, and Dial (2024) found that self-myofascial release applied to the lower limbs could acutely enhance postural control, particularly when measured

through tools such as the Y-Balance and Star Excursion Balance Tests. However, their study was limited to female participants and employed different measurement tools and protocols, which may account for the discrepancy in findings.

Future research should explore these variables further by including more diverse populations (e.g., athletes, sedentary individuals, older adults), using alternative balance assessments, and incorporating tools such as electromyography (EMG) to investigate neuromuscular activation. Additionally, longer-term interventions with increased volume or frequency may help determine whether chronic foam rolling can yield measurable improvements in balance.

This study has several limitations. First, the participant pool consisted solely of young, physically active males, limiting the generalizability of the findings to other populations, such as sedentary individuals, females, or older adults. Second, the intervention was acute and short-term in nature, which may not have provided sufficient stimulus to influence balance outcomes. Future studies should consider longitudinal designs to assess potential cumulative effects. Third, while participants were instructed to refrain from additional high-intensity training outside of the study, physical activity levels were not objectively monitored. The absence of precise activity tracking may have introduced variability in baseline conditions. Future studies should incorporate objective monitoring tools (e.g., activity trackers, logs) to better control for confounding variables and improve internal validity.

In summary, the findings of this study indicate that neither foam rolling nor dynamic stretching exercises produce significant acute improvements in dynamic balance among physically active young men. These results are consistent with previous research that questions the effectiveness of such techniques in enhancing postural control when applied in isolation. While foam rolling and stretching may serve other purposes, such as improving flexibility or reducing muscle soreness, they should not be relied upon as primary methods for enhancing balance.

Ethics Committee Approval Information

Ethics Review Board: Ethics Committee of Selcuk University, Faculty of Sports Science, Konya, Turkey.

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Researchers' Contribution Statement

Within the scope of the study, the authors have equal contributions

Conflict of Interest

There is no personal or financial conflict of interest within the scope of the study

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