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Comparison of the acute effects of static and dynamic stretching exercises on the balance performance of Turkish wrestlers

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Abstract

Background The importance of dynamic and static stretching exercises on motoric abilities before an athletic performance is well known. However, there is limited information about their effects on balance performance. For this reason, this study aimed to investigate the acute effects of static and dynamic stretching exercises on wrestlers' balance performance and compare wrestlers' balance levels according to their wrestling styles.

Method A total of 28 wrestlers who performed dynamic stretching ($n=14$) and static stretching ($n=14$) protocols voluntarily participated in the study. Data were collected using Togu Challenge Disc 2.0. An independent samples t-test was applied to compare the data that were determined to show normal distribution.

Results When comparing dynamic balance according to warm-up protocols, it was found that there was a significant difference in favor of wrestlers who performed dynamic stretching ($p=0.023$). However, no statistically significant difference was found between static and dynamic stretching groups in terms of static balance ($p=0.238$). Additionally, while a significant difference was observed in the wrestlers' dynamic balance scores in both dynamic and static stretching exercises in favor of freestyle wrestlers ($p=0.008$; $p=0.022$), a significant difference was found in static balance scores in favor of Greco-Roman wrestlers ($p=0.014$; $p=0.018$).

Conclusion Dynamic stretching exercises were found to support wrestlers' balance performance more than static stretching. The results showed that the different warm-up protocols applied before training and competition can have different effects on the wrestlers' performance. Therefore, it is suggested that wrestlers should prefer warm-up protocols including dynamic stretching exercises to optimize pre-performance balance outcomes.

Keywords Athletic performance, Balance, Exercise, Stretching, Wrestling

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Introduction

Wrestling is considered one of the oldest sports branches in human history since the ancient Olympics [1]. Wrestling is performed in two different categories as freestyle (for men and women) and Greco-Roman (only for men) style at the international level [2, 3]. Freestyle and Greco-Roman wrestling are the two main internationally recognized wrestling styles. Freestyle wrestling is a style in which the athletes can touch the entire body of their opponents (from the head to the ankles) and is applied in both men's and women's categories. On the other hand, Greco-Roman wrestling is practiced only among men and does not permit below-the-belt contact or techniques; the competition is limited to the areas above the belt [4].

In wrestling, balance supports the athlete's performance by ensuring that the movements are performed in a controlled and harmonious manner. Mirzaei and Akbar (2008) reported that athletes can use more than 500 techniques to gain superiority over their opponents during wrestling competition [5]. For the use of these techniques, athletes utilize almost all of their motoric abilities. Wrestlers need the maximum level of dynamic balance during both defense and offense to lift and drop the opponent on the mat while resisting the opponent's moves [6, 7]. Balance is a critical parameter for performing at a high level and improving performance, and impairments in balance performance are also recognized as a risk factor [8]. In studies conducted in different sports disciplines, Barbado et al. (2016) reported that elite-level athletes develop balance control in line with the requirements of their branches and exhibit this skill effectively on the field [9].

Sportive activities require higher effort compared to daily standard activities and cause physiological and psychological reactions in the organism. For this reason, the body is prepared by gradually loading before training [10]. Activities that prepare the athlete for the competition and aim to increase his/her performance by positively affecting it are called 'warm-up' [11]. According to some experts, warm-up prepares the athlete mentally, while according to others, it is aimed at protecting the circulatory system and musculoskeletal structure [12]. Warm-up protocols are among the pre-exercise practices that prepare the body for challenging activities both physiologically and psychologically in all sports branches, have proven effectiveness, and are used by many athletes [13–15]. These pre-exercise routines are widely preferred by individuals participating in sports activities. Stretching practices, which are frequently performed before training and exercise, improve joint range of motion as well as increase muscle elasticity, thus increasing sportive performance and reducing the risk of injury that may occur during challenging exercises [14, 16].

A certain level of joint mobility is required in all sportive activities [17]. Dynamic and static flexibility plays an important role not only in sports activities but also in the realization of daily life activities [18]. In traditional warm-up periods, static stretching or dynamic stretching exercises are applied after aerobic running. During dynamic stretching, the muscle contracts by extending, and in this process, the muscle, joint, tendon, and ligament structures work together to produce power. Repetition of this movement provides a significant range of motion capability [19]. On the other hand, in static stretching, after the muscle is extended, it is kept constant for a certain period, and the muscle length is maintained [20]. When the literature is examined, studies examining the various effects of static and dynamic stretching exercises on motoric abilities have been conducted, and various opinions have been put forward. While the studies suggest that static stretching exercises prevent athletes from achieving real performances and negatively affect their performance [15, 18, 21–25], there are studies suggesting that dynamic exercises improve performance and increase performance [26–28].

Effective use of motoric abilities, applicability of technical skills, and balance control are the basic elements of being successful in wrestling [29, 30]. In this context, warm-up protocols that enable athletes to prepare physically and mentally for competitions are of great importance. Dynamic and static stretching applications reduce the risk of injury by increasing the range of motion of the joints, while contributing to the flexibility and strength of the muscles. Correct and scientifically based warm-up routines help wrestlers to perform more effectively in both training and competition. Additionally, determining and applying appropriate warm-up methods for wrestlers is considered as a critical factor for the sustainability of performance in wrestling. In this context, this study aimed to investigate whether static and dynamic stretching exercises influenced the balance performance of wrestlers and to compare them according to the styles of wrestlers. The hypotheses of the current study are as follows.

H_1: There are differences in wrestlers' Dynamic and Static balance scores according to Dynamic and Static warm-up protocols.

H_2: There are differences in Dynamic and Static balance scores of wrestlers in different wrestling styles according to Dynamic and Static warm-up protocols.

Method

Study design

In this study, an experimental research method, which is one of the quantitative research methods, was used. Experimental research was a method in which variables and factors could be controlled in an environment, and

the results were monitored. In this method, the aim was to reveal the cause-and-effect relationships in the examined event [31].

Study sample

G-Power analysis was used to determine the sample group of the study. The total number required for the expectation of a large effect size (f = 1.0) to be statistically significant was determined as 28 (14 people for each group) ($\alpha = 0.05$; $1\text{-}\beta = 0.80$). The sample of the study consisted of male college wrestlers aged 18 and over registered at Balıkesir University Faculty of Sports Sciences. The research group consisted of a total of 28 wrestlers and was divided into two groups of 14 people each, to perform static warm-up ($n = 14$) and dynamic warm-up ($n = 14$) using a random sampling method.

Inclusion criteria for participation in the study were as follows: being an active male wrestler aged 18 years or older, being enrolled in the Faculty of Sports Sciences, having no current musculoskeletal injury, and volunteering to participate in the study. Exclusion criteria included having any recent surgery, chronic health problems, or using medication that could affect balance or neuromuscular performance. All participants were experienced wrestlers with a minimum of 5 years of training history. They trained regularly 4–6 days per week, with each training session lasting approximately 90–120 min. Training sessions included general physical preparation, technical and tactical drills, and conditioning exercises. The intensity of training was moderate to high, depending on the periodization phase. Regarding competition level, 60% of the athletes had experience at the national level, while the remaining 40% had competed in both national and international tournaments.

Experimental design

Warm-up protocol

Before starting the warm-up protocol, the athletes were made to jog at low and medium intensity for five minutes to prepare their bodies for physical activity. This process aimed to accelerate circulation by increasing muscle temperature, increasing joint mobility, and minimizing possible injury risks. Then, dynamic and static stretching exercises covering the whole body were applied to the groups in two different ways designed by the researchers based on previous research. Details regarding the warm-up protocol are given in Table 1.

Data collection tools

Togu challenge disc 2.0

Togu Challenge Disc 2.0 was used in the study to measure static and dynamic balance. Togu Challenge Disc 2.0 was a portable balance measurement and training device that works connected to phones and tablets via Bluetooth. It can perform dynamic and static balance measurement with various motion sensors [Figure 1].

For the static balance measurement, there are 5 circles in the center of the screen, scoring from 1 to 5 towards the edges. Wrestlers aim to maintain this position by watching the screen for 20 s while trying to keep the point connected to the balance device fixedly in the center of the screen. In this test, the wrestlers were scored

Table 1 Static and dynamic stretching exercises

Dynamic Stretching (Warm-up) Movements	Static Stretching (Warm-up) Movements
Neck rolls - The head is slowly turned to the right and left (10–15 s)	**Lateral Neck Stretch -** The head is tilted to the side, and slightly pulled with the help of the hand. (20–30 s)
Shoulder Rolls - Shoulders are rotated in a circular motion forwards and backwards (15 s)	**Shoulder Stretch -** One arm is pulled to the opposite side at chest level. (20–30 s)
Arm Swings - Arms swing forwards and backwards (15 s)	**Triceps Stretch -** One arm is brought behind the head, and the elbow is pressed down with the other hand. (20–30 s)
Torso Twists - The upper body is rotated to the right and left. (15 s)	**Side Body Stretch -** One arm is lifted up and leans to the side. (20–30 s)
Lunge with Rotation - The upper body is rotated while lunging forwards. (15 s)	**Lower Back Stretch -** Lying on the back, the knees are pulled to the chest. (20–30 s)
Calf Raises - Rise and fall movement is made on the toes of the feet. (15 s)	**Calf Stretch -** One foot in front and the other behind, the heel is kept pressed to the floor. (20–30 s)
Ankle Rolls - Ankles are rotated in a circular motion. (15 s)	**Hamstring Stretch (Seated Hamstring Stretch) -** Seated on the floor with one leg straight and the other bent and lean forward. (20–30 s)
High Knees - Knees are pulled to the chest alternately. (20 s)	**Knee to Chest Stretch -** Lying on the back, the knee is pulled to the chest. (20–30 s)
Side Lunges - Squatting movement is performed by bending to the side with legs spread. (15 s)	**Inner Thigh Stretch -** In the sitting position, the soles of the feet are joined, and the knees are brought closer to the ground. (20–30 s)
Jumping Jacks - Arms and legs are opened and closed synchronously. (30 s)	**Quadriceps Stretch (Standing Quad Stretch) -** Standing on one leg, the other leg is pulled back. (20–30 s)
Butt Kicks - Heels are pulled towards the buttocks alternately. (20 s)	**Butterfly Stretch -** The soles of the feet are joined, and the knees are brought closer to the ground. (20–30 s)

Fig. 1 Togu Challenge Disc 2.0

according to their level of maintaining their balance, and the results were evaluated with a minimum score of 1 and a maximum score of 5. The result obtained after 20 s was recorded as the static balance score.

Dynamic balance measurements consist of tasks that require the wrestlers to follow the targets given on the screen by actively controlling the balance disc. Each stage has a certain score range, and the minimum score that the wrestlers can achieve in total was determined as 0 and the maximum score was 900.

The score obtained after the test was completed was recorded as the dynamic balance score (MFT Bodyteamwork, n.d.). The Level 1 mode of the TOGU Challenge Disc device was used to evaluate both the Dynamic and Static balance levels of wrestlers. Higher scores obtained from the tests indicate a high level of balance scores. Moreover, a 10-inch tablet was used to connect the balance measurement device. Togu Challenge Disc 2.0 has been previously used in different studies to evaluate balance performance and has been accepted as a reliable measurement tool [32–35]. Hildebrandt et al. (2015) determined the test-retest intraclass correlation coefficient for TOGU Challenge Disc 2.0 as 0.688 [36]. The sensitivity and portability of this device are one of the main reasons why it was preferred in this research.

Data collection method

Wrestlers selected voluntarily were randomly divided into two groups. Static stretching exercises were applied to one group, and dynamic stretching exercises were applied to the other group. To prevent the athletes from cooling down, each wrestler was subjected to static and dynamic balance tests after completing the specified warm-up protocol, respectively. Before the test, the participants were briefly informed about the use of the device, and familiarization was applied. The familiarization period consisted of a short trial session lasting approximately 3–5 min, during which the participants were allowed to experience the device and receive feedback on their posture and balance. Measurements were taken with hands in the free position and knees slightly bent. A tablet was placed at eye level so that the wrestlers could see the screen better. Each athlete was tested 2 times and their best grade was evaluated. The measurements were performed between 09.00 and 12.00 at Balıkesir University Faculty of Sport Sciences. Participants wore sports shoes during the balance tests, and clothes that would allow them to move comfortably were preferred.

Statistical analysis

Static and dynamic balance data obtained from wrestlers were transferred to the SPSS 30 (IBM Corp., Armonk, NY, USA) package program, and statistical analyses were performed. It was determined that the obtained data met the normality criteria (Shapiro-Wilk test results), and parametric tests were applied. The assumption of homogeneity of variances was tested using Levene's test, and it was determined that the variances were homogeneous. The differences between the independent variables (warm-up protocols) and the dependent variables (dynamic and static balance scores) were compared by an independent samples t-test. Besides, the differences between the independent variables 'wrestling styles' and dynamic and static balance scores were also analyzed by an independent samples t-test. Effect sizes of differences between groups (binary comparisons) were calculated with Cohen's d. The significance level was set at 0.05 in all statistical analyses.

Results

When the descriptive statistics of the wrestlers were analyzed in Table 2, there was no statistical difference between the age, height, body weight, and BMI averages of the wrestlers in the static and dynamic stretching exercise groups.

Table 2 Comparison of descriptive statistics of the wrestlers according to warm-up groups

Variables	Warm-up Groups	Min	Max	Mean ± S.D.	E.S. Cohen's d	t	*p*
Age (year)	Dynamic Stretching	18	26	21.86 ± 1.92	0.411	-1.088	0.287
	Static Stretching	20	26	22.64 ± 1.91			
Height (cm)	Dynamic Stretching	169	188	176.93 ± 4.87	0.074	−0.197	0.846
	Static Stretching	164	190	177.36 ± 6.54			
Weight (kg)	Dynamic Stretching	65	120	91.57 ± 16.01	-0.559	1.480	0.151
	Static Stretching	60	130	82.21 ± 17.43			
BMI (kg/m^2)	Dynamic Stretching	22.76	38.42	29.20 ± 4.68	-0.607	1.607	0.120
	Static Stretching	22.31	42.94	26.12 ± 5.46			

$p > 0.05$; S.D: Standard Deviation; E.S.: Effect Size

Table 3 Comparison of balance scores according to warm-up protocols

Balance Tests	Warm-up Protocol	*n*	Mean ± S.D.	E.S. Cohen's d	t	*p*
Dynamic	Dynamic Stretching	14	590.00 ± 69.91	-0.910	2.407	**0.023***
	Static Stretching	14	525.64 ± 71.54			
Static	Dynamic Stretching	14	4.04 ± 0.49	-0.273	0.723	0.238
	Static Stretching	14	3.89 ± 0.60			

*$p < 0.05$; S.D: Standard Deviation; E.S.: Effect Size

Table 4 Comparison of balance scores according to wrestling style

Warm-Up Protocols	Balance Tests	Wrestling Style	*n*	Mean ± S.D.	E.S. Cohen's d	t	*p*
Dynamic Stretching	Dynamic Balance	Freestyle	10	618.80 ± 59.85	1.880	3.177	**0.008***
		Greco-Roman	4	518.00 ± 27.57			
	Static Balance	Freestyle	10	3.85 ± 0.45	-1.707	-4.497	**0.014***
		Greco-Roman	4	4.51 ± 0.09			
Static Stretching	Dynamic Balance	Freestyle	9	556.78 ± 47.79	1.472	2.639	**0.022***
		Greco-Roman	5	469.60 ± 77.18			
	Static Balance	Freestyle	9	3.62 ± 0.53	-1.522	-2.728	**0.018***
		Greco-Roman	5	4.36 ± 0.38			

*$p < 0.05$; S.D: Standard Deviation; E.S.: Effect Size

When Table 3 was examined, a statistically significant difference was observed between the dynamic balance scores of wrestlers who performed dynamic and static warm-up protocols ($p < 0.05$), whereas no significant difference was found in their static balance scores ($p > 0.05$).

A statistical difference was observed between the dynamic and static balance levels of freestyle and Greco-Roman wrestlers after dynamic and static stretching exercises ($p < 0.05$). According to this result, the dynamic balance of freestyle wrestlers was higher than Greco-Roman wrestlers after both dynamic and static stretching exercises, whereas the static balance of Greco-Roman wrestlers was higher than freestyle wrestlers (Table 4).

Discussion

Static and dynamic balance were considered as one of the main factors determining performance in many sports. Loss of balance not only negatively affects sportive performance but also may increase the risk of injury. Therefore, rapid improvement of impaired balance was considered a critical skill after sport-specific movements [37]. Balance was one of the basic elements of motor skills, ranging from maintaining posture to the application of complex sports skills [38]. In this context, it can be accepted that balance and body stability were important factors for wrestlers to maintain their position against their opponents, to perform movements such as pushing, pulling, and falling effectively, and to develop wrestling-specific techniques and skills. In this study, we aimed to determine the effect of static and dynamic stretching exercises on dynamic and static balance levels in wrestlers.

When the dynamic balance of the wrestlers was compared according to and warm-up protocols (static and dynamic stretching), a significant difference was found in favor of the wrestlers performing dynamic stretching. The wrestlers who performed dynamic stretching exercises showed higher dynamic balance performance than the wrestlers who performed static stretching exercises (Table 3). The higher performance of dynamic stretching

wrestlers in dynamic balance scores may be associated with their muscle activation, neuromuscular stimulation and central nervous system activation [39]. Because it has been reported that dynamic stretching exercises can increase body control and balance by activating muscle spindles and proprioceptive receptors more [40–42]. Moreover, it has been reported that while it accelerates reaction time by preserving muscle elasticity, it can also contribute to the more efficient functioning of the muscle-tendon structure [43]. While static stretching may cause muscle relaxation and temporary loss of strength [9, 44–46], dynamic stretching may improve balance by supporting movement preparation. Especially in sports such as wrestling, where it is critical to constantly change direction, prevent loss of balance, and provide stability, dynamic stretching may positively affect balance control by supporting sport-specific movement patterns. In literature, there were studies supporting that dynamic stretching movements increase performance in sports branches such as wrestling, where explosiveness, displacement, and trunk stability parameters were important [47–50]. Therefore, the fact that wrestlers who applied dynamic stretching had higher dynamic balance scores may be due to the fact that these exercises were more effective in sport-specific preparation processes. Erkut et al. (2017) investigated the effect of different warm-up protocols on dynamic balance and concluded that dynamic and static stretching improved balance performance [51]. Although this study supported our research in favor of dynamic stretching, it did not support it in favor of static stretching. Nejati et al. (2015) stated that different warm-up protocols affected balance performance compared to no stretching and found that although there was no statistical difference in the balance performance of the dynamic and static stretching groups, the effect size was in favor of the dynamic stretching group [52]. Ahsan and Mohammed (2018) stated that different warm-up protocols did not affect dynamic balance in a study conducted on athletes from different branches [53]. Fletcher and Monte-Colombo (2010) suggested that dynamic stretching causes an increase in sports performance compared to static stretching [54]. When the literature was examined, although there were many studies examining the effect of stretching exercises on sportive performance and motoric abilities, studies examining the effect of stretching exercises on balance levels were limited.

There was no statistically significant difference between static balance according to warm-up protocols (static and dynamic stretching). It was observed that dynamic or static stretching exercise did not affect the static balance performance of wrestlers (Table 3). Balance was generally a skill in which muscles actively work to provide stability. Both static and dynamic stretching were exercises to increase the flexibility of the muscles, but these exercises were not directly aimed at improving the ability to maintain balance. Static balance required the body to remain balanced in a fixed position, while dynamic balance referred more to the ability to maintain balance during movement. Static balance was related to the body's ability to maintain balance in a fixed position. Static and dynamic stretching exercises were mainly aimed at stretching the muscles and increasing their flexibility of the muscles. However, such exercises may not directly improve the muscle tone and active stability necessary to maintain balance. Therefore, there might not be a significant difference in the parameters measuring static balance [55–57]. When the literature was examined, a limited number of studies examining the effect of stretching exercises on static balance performance were found. In the study conducted by Akyüz et al. (2017) on basketball players, it was concluded that static and dynamic stretching exercises had no effect on the balance levels of athletes [57]. Nejati et al. (2015) investigated the effects of different warm-up methods on static balance with 15 people between the ages of 18 and 30 and found that static stretching had no significant effect on balance compared to no stretching [52]. In a study conducted by Behm and Chaouachi (2011), it was found that moderate flexibility training can positively affect static balance [21]. Daneshjoo et al. (2012) reported that static stretching and dynamic warm-up applications had positive effects on balance without a statistically significant difference between dynamic and static stretching [58]. Previous studies have shown that the effect of stretching exercises on static balance is limited, and these results support our study.

When the dynamic and static balance scores of wrestlers who performed static and dynamic stretching exercises were compared according to their wrestling styles, the dynamic balance scores of freestyle wrestlers who did both dynamic and static stretching exercises were higher than those of Greco-Roman wrestlers. On the other hand, the static balance of Greco-Roman wrestlers was higher than that of freestyle wrestlers (Table 4). The differences in dynamic and static balance between freestyle and Greko-Roman wrestlers may be directly related to the technical structure, training methodology and muscle activation patterns of wrestling styles [59–61]. In freestyle wrestling, athletes use more mobility, rapid changes of direction and techniques based on leg attacks. This situation leads to the development of dynamic balance skills, resulting in freestyle wrestlers having higher dynamic balance scores compared to the wrestlers of the armored style. Moreover, freestyle wrestlers' low posture and continuous movement improve their ability to maintain and regain balance. On the other hand, since wrestlers must use only upper body techniques in wrestling,

their posture control and balance maintenance skills in fixed positions are developed more. Elements such as pushing, pulling, and resisting the opponent in a fixed position provide higher static balance skills compared to freestyle wrestlers. This difference was also supported by the fact that in the training process, the wrestlers performed upper body-centered strength and stability exercises. As a result, it can be said that freestyle wrestlers were superior in dynamic balance due to their intensity of movement, whereas the wrestlers were superior in static balance due to their techniques based on fixed postures.

Conclusion and Recommendations

This study examined the effects of static and dynamic stretching exercises on the balance performance of wrestlers and tried to determine which method was more advantageous in training and competition processes. The results of the study showed that dynamic stretching exercises support the balance performances of wrestlers more than static stretching. In line with the results of the study, it was understood that the warm-up protocols applied before training and competition can directly affect the athlete's performance. It is thought that dynamic stretching exercises may contribute to wrestlers' motor control mechanisms and neuromuscular coordination by providing more active stimulation of the musculoskeletal system, whereas static stretching has a limited effect on balance performance. Therefore, it is recommended that wrestlers should prefer warm-up programs that include dynamic stretching exercises to reach the optimum balance level. Besides, providing warm-up protocols based on a branch-specific scientific basis and suitable for the individual needs of the athletes by the coaches will contribute to the performance development of the athletes. Future studies on athletes of different ages, genders, and experience levels and evaluation of long-term effects will provide more comprehensive findings on the subject. Additionally, more experimental research is needed to directly compare the balance and body stabilization levels of Greco-Roman and freestyle wrestlers, and examining traditional wrestling (Oiled, Beach, and Sumo, etc.) athletes outside of Olympic wrestling branches will also contribute to the literature.

Limitations

This study has certain limitations that should be considered when interpreting the findings. Firstly, the sample size was limited to 28 male collegiate wrestlers from a single university, which may restrict the generalizability of the results to broader populations, including female wrestlers or athletes from different competitive levels. Secondly, balance was assessed only in the short term, immediately after warm-up protocols, and no follow-up measures were conducted to determine the lasting effects of stretching interventions. Thirdly, the timing of data collection was standardized to morning hours (09:00–12:00) to reduce variability; however, individual differences in circadian rhythms may have influenced the athletes' performance, potentially affecting the consistency of the results. Fourthly, the study did not control for individual variability in factors such as fatigue level, sleep quality, or nutrition, which might have influenced balance performance. Lastly, the warm-up protocols were limited to specific static and dynamic stretching routines; different variations or durations of these protocols could potentially yield different outcomes. In addition, there was an observable imbalance in the number of participants within the subgroups, particularly in the dynamic stretching condition (e.g., 10 freestyle vs. 4 Greco-Roman wrestlers). Such sample size disparities may have reduced statistical power and increased the likelihood of Type I and Type II errors, limiting the reliability and generalizability of subgroup comparisons.

Abbreviations

BMI	Body Mass Index
Cm	Centimeter
kg	Kilogram
kg/m2	Kilogram/Square meter
E.S.	Effect Size
S.D.	Standard Deviation

Author contributions

All authors have contributed sufficiently to the manuscript and have approved the final version. E.D.: conceptualization, methodology, writing—original draft, writing—review, and editing. G.A.: conceptualization, data curation, formal analysis, resources, writing—original draft, writing—review, and editing. M.G.: conceptualization, writing—original draft, writing—review, and editing. G.C.: conceptualization, resources, writing—original draft, writing—review, and editing. F.G.: conceptualization, resources, writing—original draft, writing—review, and editing. O.I.: conceptualization, data curation, formal analysis, supervision, resources, writing—original draft, writing—review, and editing.

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Data availability

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was ethically approved by the Balıkesir University Health Sciences Non-invasive Research Ethics Committee of the relevant university with the decision dated 25.03.2025 and numbered 2025/149. This study was performed according to the Declaration of Helsinki. In addition, informed consent was obtained from all participants before study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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