ORIGINAL ARTICLE

# Comparison of anthropometric and performance characteristics in elite male football and handball players

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## ABSTRACT

Elite-level athletes develop distinct performance profiles shaped by training regimens tailored to the specific physical and physiological demands of their respective sports. The nature of the sport, training methods, and game dynamics directly influence the development of strength, power, speed, and anthropometric characteristics. In team sports, comparative evaluations of these attributes are critical for accurate performance analysis and the design of sport-specific and individualized training pro-grams. This study aimed to compare the anthropometric characteristics, strength, ex-plosive power, and speed parameters of elite male football and handball players. A total of 44 athletes (22 football players and 22 handball players) participated in this cross-sectional comparative study. Anthropometric data included height (cm), body weight (kg), and body mass index (BMI, kg/m²). Performance assessments comprised leg strength (kg), handgrip strength (kg), vertical jump height (cm), 30-meter sprint time (s), and peak power output (W). Independent samples t-tests revealed statistically significant differences between football and handball players in age ($p$ = .004), height ($p$ = .005), leg strength ($p$ = .007), and handgrip strength ($p$ < .001). No significant differences were found in other performance variables ($p$ > .05). The findings indicate that elite football and handball players exhibit sport-specific anthropometric and performance profiles. Football players showed greater lower-body strength, while hand-ball players had superior upper-body strength and greater stature. These differences underscore the importance of developing training protocols and talent identification strategies that reflect the unique demands of each sport. Coaches are encouraged to utilize sport-relevant performance tests and interpret results contextually to optimize athlete development and specialization.
**Keywords**: Performance analysis, Sport-specific training, Motor abilities, Anthropometric characteristics, Physiological profiling.

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## INTRODUCTION

Elite athletes undergo intensive and systematic training processes tailored to the specific physical, physiological, and neuromuscular demands of their respective sports, shaping their performance in accordance with the requirements of their discipline (Akçınar & Macit, 2020; Viru, 2017; Brewer, 2017). The nature of the sport, its structural and temporal dynamics, and training modalities directly influence the development of key motor characteristics such as strength, power, speed, and agility (Reza et al., 2024; Formenti et al., 2021; Young, Dawson & Henry, 2015; Strafford et al., 2018). Consequently, athletes participating in different sports disciplines develop distinct performance profiles in response to sport-specific training stimuli (Reza et al., 2024). Scientifically identifying these performance differences allows for a better understanding of athletes' needs and facilitates the design of individualized training programs.

In team sports, performance is not solely determined by technical and tactical skills but is also closely linked to physical capacity (Forsman, et al., 2016; Montenegro Bonilla et al., 2024; Eusebio, Prieto-González, & Marcelino, 2025). Parameters such as strength (Ioannis, 2013), explosive power (Aksović et al. 2020), and speed (Singh et al., 2024; Ben Brahim et al., 2021) are among the fundamental factors that influence athletic effectiveness during competition. The development of these parameters is critical both for general motor performance (İlbak & Akarsu, 2022) and for the effective execution of sport-specific skills (Montenegro Bonilla et al., 2024; Bishop & Girard, 2013). In this context, comparative evaluations of the physical performance characteristics of athletes across different sports disciplines significantly contribute to both coaching decision-making and the scientific knowledge base surrounding athlete development.

Football and handball are two distinct team sports that differ markedly in terms of playing field dimensions, level of physical contact, movement patterns, and energy system demands. Football is played on a large field and relies heavily on aerobic capacity, repeated sprint ability, change of direction skills, and lower limb strength (Curtis et al., 2019; Strudwick, 2016; Nobari et al., 2023). In contrast, handball is a high-intensity sport played in a smaller area, characterized by frequent physical collisions, rapid offensive-defensive transitions, and an emphasis on upper-body strength and explosive jumping ability (Srce & Računski Centar, 2025; Manchado et al., 2013). These differences likely result in divergent training content and physiological adaptations for athletes in each sport, fostering sport-specific development patterns in performance-determining attributes such as strength, power, and speed.

Existing literature reports that football players typically demonstrate superior values in aerobic endurance (Manouvrier, Cassirame, & Ahmaidi, 2016), repeated sprint ability (Nowak et al., 2025), and lower-extremity motor skills (Komarudin et al., 2022; Castagna et al., 2006), whereas handball players exhibit advantages in upper-body strength (Rahman & Sharma, 2023; Hermassi et al., 2016), explosive jumping ability, and anaerobic power output (Wagner, Fuchs, & von Duvillard, 2018; Kyriacou-Rossi, Hadjicharalambous, & Zaras, 2024; Muhammad & Allawy, 2023). However, studies directly comparing these two sports using standardized methodologies and multidimensional neuromuscular performance metrics remain limited. Interdisciplinary comparative research—particularly in areas such as strength modalities, sprint performance, and explosive power—plays a crucial role in advancing performance science and in clarifying the sport-specific physical requirements of different athletic disciplines.

In this context, the aim of the present study is to comparatively examine the anthropometric characteristics, strength, explosive power, and speed parameters of elite football and handball players. The findings obtained are expected to provide valuable insights for identifying sport-specific performance profiles, optimizing training programs accordingly, and grounding talent identification and selection processes in more scientific principles.

## MATERIALS AND METHODS

### *Participants*

The minimum required sample size for this study was determined through an a priori power analysis conducted using G*Power version 3.1.9.7. The analysis was based on an effect size of 0.80, a significance level ($\alpha$) of .05, and a statistical power ($1-\beta$) of 0.80. The results indicated that a total of at least 42 participants—21 per group—would be sufficient. Accordingly, the study included a total of 44 male athletes: 22 active football players and 22 active handball players. All participants had been training regularly and competing actively in their respective sports for a minimum of three years.

Specific inclusion criteria were applied to determine eligibility for participation. These criteria included: being male, aged between 18 and 30 years, having a minimum of three years of regular training experience in football or handball, being free from any chronic illness or musculoskeletal disorder, and signing an informed consent form. Exclusion criteria included: falling outside the specified age range, having experienced a serious injury within the past six months, lacking consistent training history, being unfit for testing on the test day due to health reasons, and failure to provide informed consent. Descriptive statistics for both groups are presented in Table 1.

Table 1. Descriptive statistics of the groups

| Variable | Group | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Age (years) | Football | 19 | 26 | 22.64 | 1.76 |
| | Handball | 17 | 26 | 20.18 | 3.30 |
| Training experience (years) | Football | 5 | 20 | 10.59 | 3.74 |
| | Handball | 5 | 16 | 9.00 | 2.43 |
| Height (cm) | Football | 165 | 191 | 177.09 | 6.05 |
| | Handball | 176 | 197 | 182.50 | 6.14 |
| Body weight (kg) | Football | 67.50 | 87.30 | 75.67 | 6.05 |
| | Handball | 65.90 | 102.00 | 79.89 | 9.10 |
| BMI (kg/m²) | Football | 21.19 | 26.92 | 24.14 | 1.66 |
| | Handball | 20.80 | 28.86 | 23.96 | 2.23 |

### *Research design*

This study was conducted using a comparative cross-sectional research design. The sample included a total of 44 male athletes, comprising 22 football players and 22 handball players. The data collection process commenced after obtaining ethical approval from the Düzce University Ethics Committee (approval number: 2025/74; date: 27.02.2025). During the first session, the purpose, scope, and procedures of the study were explained to the participants both verbally and in written form, in a clear and comprehensible manner. Written informed consent was obtained from all participants, and the study was conducted in accordance with ethical principles. In the second session, anthropometric measurements were collected. These included height (cm), body weight (kg), and body mass index (BMI, kg/m²), along with demographic information such as chronological age and training age. Additionally, pilot testing protocols were implemented to familiarize participants with the testing procedures and to minimize potential measurement errors during the actual data collection. In the third session, the participants underwent the main performance tests, which included measurements of leg strength (kg), handgrip strength (kg), vertical jump height (cm), sprint time (seconds), and peak power output (Watts). The data obtained from these tests were statistically analysed and the results were interpreted and reported accordingly. An overview of the research design and procedural flow is presented in Figure 1.

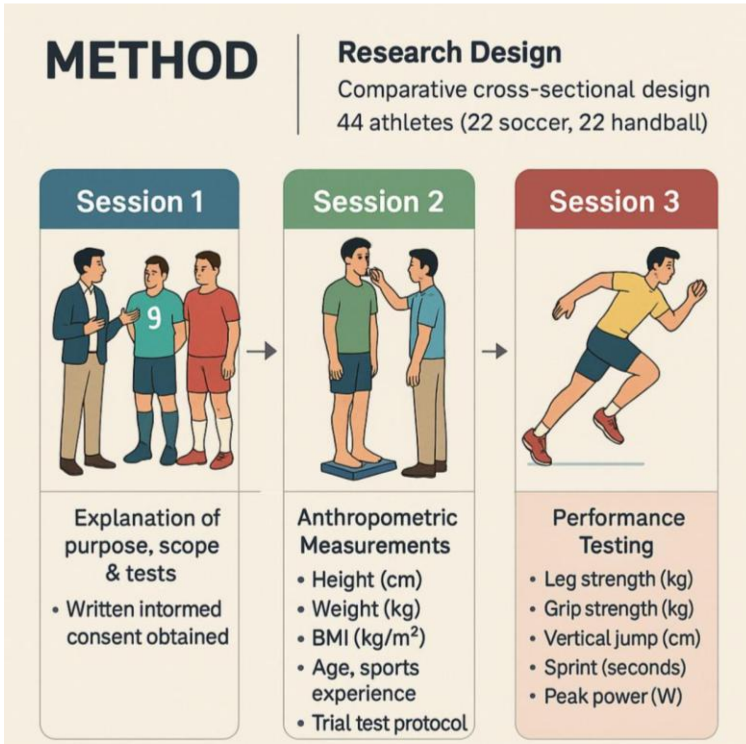


Figure 1. An overview of the research method.

***Anthropometric measurements***

All anthropometric measurements in this study were conducted by a trained researcher in accordance with the standards of the International Society for the Advancement of Kinanthropometry (ISAK) (Olds & Stewart, 2006). Standardized measurement tools were used throughout the data collection process. All data were gathered with strict adherence to reliability and validity principles, including repeated measurements and regular device calibration.

*Height measurement*

Participants' height was measured while they stood barefoot in an upright position, with their head aligned to the Frankfurt horizontal plane. Measurements were taken using a Seca 213 portable stadiometer (Seca GmbH & Co. KG, Hamburg, Germany), and values were recorded in centimetres (cm). During measurement, participants' heels, buttocks, back, and head were in contact with the vertical measurement plane to ensure accuracy.

*Body weight measurement*

Body weight was assessed while participants stood on a flat and stable surface, barefoot and wearing light clothing, in an upright posture. Measurements were obtained using an Omron HN-289 digital scale (Omron Healthcare Co., Ltd., Kyoto, Japan) and recorded in kilograms (kg). Prior to each use, the device was checked to ensure proper functioning.

 

*Body Mass Index (BMI)*

BMI was calculated using participants' height and body weight data. The Body Mass Index was computed by dividing body weight in kilograms by the square of height in meters, using the following formula:

$$\text{BMI (kg/m}^2\text{)} = \text{Body Weight (kg)} / \text{Height (m)}^2$$

### ***Performance tests***

The physical performance tests implemented in this study aimed to assess the participants' fundamental motor characteristics, such as strength, power, and speed. To obtain valid and reliable results, tests were administered in a specific sequence, taking into consideration participants' energy systems and muscle fatigue levels (Brown & Weir, 2001; Mackenzie, 2005). Prior to the testing protocol, participants completed a dynamic warm-up routine recommended by Kurak et al. (2024). The testing sequence began with the 30-Meter Sprint Test, which assesses high-intensity anaerobic capacity. Administering this test early ensures that the central nervous system and major muscle groups are not yet fatigued, preserving sprint performance accuracy. Next, the Vertical Jump Test was conducted to evaluate lower-body explosive strength. At this point, lower-limb muscles remained active, minimizing external impact on jump performance. Jump height data obtained from this test were then used to calculate peak power output using the Harman formula (Harman et al., 1991), thus evaluating not only jump height but also the power produced. Following the jump test, lower-body strength was measured using a Takei brand leg dynamometer. Since this isometric test induces less metabolic fatigue than dynamic efforts, its placement at this stage was deemed appropriate. Lastly, the Handgrip Strength Test was administered to assess upper-body strength. Due to its low energy demand and minimal interference from previous tests, it was placed at the end of the sequence. Adequate recovery periods (3–4 minutes) were provided between tests to minimize any residual effects and ensure accurate performance representation.

*30-meter sprint test*

The 30-Meter Sprint Test was used to assess participants' short-distance sprinting performance. The test was conducted on a flat, non-slip surface marked with a 30-meter sprint track. Participants wore appropriate sports attire and received standardized warm-up and test instructions beforehand. The sprint started from a stationary standing position, and reaction time was not included in the measurement. Sprint times were recorded using photocell timing gates (Brower Timing Systems, Utah, USA) placed at the start and finish lines. Each participant was given two trials with a 4-minute rest between attempts. The best sprint time, measured in seconds, was used for analysis (Mackenzie, 2005).

*Vertical jump height*

To evaluate lower-limb explosive power, a squat jump test was administered (Mackenzie, 2005; Loturco et al., 2020). Participants began in an upright position, descended to approximately 90° of knee flexion, held this position for three seconds, and then performed a maximal vertical jump with hands placed on the hips. Arm swing was restricted to isolate the contribution of the lower-extremity muscles. Jump height was measured using the Optojump Next vertical jump analysis system (Microgate, Bolzano, Italy), which uses infrared optical sensors. Data were collected via a module fixed to the participant's waist and synchronized with the system. Results were recorded in centimetres (cm). Each participant completed two trials, with 4-minute rest intervals. The best result was used for analysis (Glatthorn et al., 2011).

*Peak power calculation*

Using jump height values, peak power output of the lower limbs was calculated with the Harman equation (Harman et al., 1991), which incorporates both body mass and jump height:

$$\text{Peak Power (W)} = 61.9 \times \text{Jump Height (cm)} + 36.0 \times \text{Body Mass (kg)} + 1822$$

This equation estimates explosive power potential in watts (W) based on vertical jump performance.

*Lower body strength test*

To assess isometric lower-body strength, a standard protocol using a Takei leg dynamometer (Takei Scientific Instruments Co., Ltd., Japan) was applied (Harman et al., 1991). This test targets major muscle groups around the knee joint, particularly the quadriceps and hamstrings. Participants stood on a stable surface with feet shoulder-width apart. The grip bar connected to the dynamometer was adjusted according to the individual's height and leg length, ensuring approximately 130–140° of knee flexion, an optimal angle for maximal isometric force production. Participants were instructed to maintain an upright posture and pull the bar upward with maximum force using only the lower body, while keeping hands in a static grip and avoiding involvement of the upper body. Posture was strictly monitored to eliminate upper-body contribution. Two trials were allowed per participant, with a 60-second rest between trials. The highest value, measured in kilograms (kg), was used in the analysis (Eyuboglu et al., 2019).

*Grip strength test*

To assess handgrip strength, a digital hand dynamometer (Takei T.K.K. 5401, Japan) was used. The test was performed using only the participant's dominant hand. During testing, participants stood upright in a neutral anatomical position, arms relaxed at their sides, and elbows fully extended. The dynamometer was adjusted to fit each participant's hand size for optimal grip comfort. Participants were instructed to squeeze the device as hard as possible for three seconds without moving their body (i.e., no swinging or pressing with the torso). Two trials were conducted with a 60-second rest between them. The highest value, recorded in kilograms (kg), was included in the analysis (Mackenzie, 2005).

### *Statistical analysis*

All data obtained from the study were analysed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). To examine the distribution characteristics of the data, skewness and kurtosis coefficients were initially assessed. Values for each variable falling within the range of -2 to +2 were interpreted as indicating a normal distribution (Kim, 2013; Mishra et al., 2019). Prior to between-group comparisons, Levene's Test for Equality of Variances was conducted to assess the homogeneity of variances across independent samples. The results of this test were taken into account to determine which version of the independent samples t-test would be applied for group comparisons. To evaluate statistical differences in means between the football and handball groups, the Independent Samples t-test was used. For all analyses, the level of statistical significance was set at $p < .05$.

## RESULTS

The findings obtained based on the data collected in this study are presented in Table 2.

Table 2 shows that there were statistically significant differences between football and handball players in age ($p = .004$), height ($p = .005$), leg strength ($p = .007$), and grip strength ($p < .001$). Football players were older and had higher leg strength, while handball players were taller and had greater grip strength. No significant differences were found in sports age, weight, BMI, vertical jump, sprint time, or peak power ($p > .05$).

 

Table 2. Comparison of physical characteristics and performance indicators of football and handball players.

| Variable | Group | Mean ± SD | t | df | *p* |
|---|---|---|---|---|---|
| Age (years) | Soccer | 22.64 ± 1.76 | 3.075 | 32.034 | .004* |
| | Handball | 20.18 ± 3.30 | | | |
| Sports age (years) | Soccer | 10.59 ± 3.74 | 1.674 | 42 | .102 |
| | Handball | 9.00 ± 2.43 | | | |
| Height (cm) | Soccer | 177.09 ± 6.05 | -2.944 | 41.990 | .005* |
| | Handball | 182.50 ± 6.14 | | | |
| Weight (kg) | Soccer | 75.67 ± 6.05 | -1.809 | 42 | .078 |
| | Handball | 79.89 ± 9.10 | | | |
| BMI (kg/m²) | Soccer | 24.14 ± 1.66 | 0.299 | 42 | .766 |
| | Handball | 23.96 ± 2.23 | | | |
| Leg strength (kg) | Soccer | 214.07 ± 30.59 | 2.883 | 33.756 | .007* |
| | Handball | 176.68 ± 52.58 | | | |
| Grip strength (kg) | Soccer | 45.18 ± 4.76 | -4.675 | 42 | .000* |
| | Handball | 52.40 ± 5.46 | | | |
| Vertical jump (cm) | Soccer | 34.27 ± 4.19 | 1.643 | 42 | .108 |
| | Handball | 31.88 ± 5.38 | | | |
| Sprint (s) | Soccer | 4.39 ± 0.25 | 1.740 | 42 | .089 |
| | Handball | 4.28 ± 0.16 | | | |
| Peak Power (W) | Soccer | 6667.62 ± 320.61 | -0.030 | 34.733 | .976 |
| | Handball | 6671.53 ± 525.46 | | | |

*Note. *p < .01.*

## DISCUSSION

This study aimed to comparatively examine the anthropometric characteristics, strength, power, and speed parameters of elite-level football and handball players. The findings revealed statistically significant differences between the two groups, particularly in terms of upper and lower extremity strength and height. These results support the discipline-specific performance profiles reported in the existing literature.

With regard to anthropometric parameters, handball players were found to be significantly taller than football players, while the difference in body weight, although not statistically significant, indicated that handball players tend to be heavier. The absence of a significant difference in BMI suggests that both groups possess a similar body composition. This may reflect comparable training loads and conditioning levels across the two sports. The height difference may be associated with sport-specific requirements in handball, where longer upper limb reach offers a positional advantage and influences talent selection (Milanese et al., 2011; Mohamed et al., 2009). Conversely, football players are known to benefit from a more compact and agile physique, which enhances mobility on the field (Bajramovic et al., 2019; Mijalković, Mladenović, & Ilić, 2023). These observations underscore the influence of sport-specific demands in shaping body composition and anthropometric profiles, as well as the role of training regimens in maintaining these characteristics (Granados et al., 2007; Matthys et al., 2011).

Despite the finding that football players exhibited significantly higher lower extremity strength (leg strength) than handball players, the current literature does not consistently support this claim. For instance, Risberg et al. (2018) reported that elite female handball players demonstrated 11% greater quadriceps strength than football players, a difference that remained significant (4.1%) even after normalization for body weight ($p < .001$ and $p = .012$). No significant difference was found in hamstring strength; however, the hamstring-to-quadriceps (H:Q) ratio was lower in handball players (0.58 vs. 0.60; $p < .02$). These findings suggest that although handball players may exhibit higher quadriceps strength, their hamstring strength may be disproportionately low. Nevertheless, numerous studies have emphasized the critical role of lower extremity strength in football performance (Gil et al., 2018; Coratella et al., 2019). The sport's large playing field, high-volume running, and lower-body-focused technical skills promote notable hypertrophy and strength development in the lower limbs (Curtis et al., 2019; Strudwick, 2016). These physiological adaptations may contribute to superior performance in leg strength tests among football players. However, the absence of consensus in the literature highlights the need for further empirical investigation.

The significantly higher handgrip strength observed in handball players can be attributed to the sport's intrinsic reliance on upper extremity function. Handball requires high-speed throwing, frequent physical contact, and advanced upper-body coordination, all of which stimulate the development of upper limb musculature (Srce & Računski Centar, 2025; Manchado et al., 2013). Therefore, it is expected that handball players outperform football players in upper-extremity-specific strength measures such as grip strength. Previous studies have demonstrated a strong association between handgrip strength and throwing velocity in handball, indicating its critical role in performance (Saavedra et al., 2018). Additionally, upper-body strength assessments such as the medicine ball throw have been shown to be effective in talent identification among youth handball players (Tsoukos et al., 2019). These findings support the notion that handball players hold an advantage over football players in motor tasks requiring upper body strength.

No statistically significant differences were identified between the two groups in sprint time, vertical jump, or peak power output. This lack of difference may be attributed to the similar physical demands and training methodologies in both sports. High-intensity, intermittent activities requiring speed, agility, and explosive strength are fundamental to both football and handball, potentially leading to convergent physiological adaptations (Halder & Rahaman, 2022). Shared emphasis on sprinting and agility in training programs may also contribute to similar performance outcomes in these parameters. Some studies have further noted that even among elite and sub-elite football players, vertical jump performance does not always differ significantly, indicating that such metrics may lack discriminatory power across sport disciplines (Kalata et al., 2023). Additionally, the limited correlation between sprinting and jumping abilities (Boone et al., 2021) suggests that these capacities are distinct and should be evaluated independently. Although group-level similarities were found, individual differences – including biomechanical structure, flexibility, and specific training focuses – may still play a decisive role in performance, which cannot be fully captured by group comparisons. This underscores the importance of evaluating athletic performance not only through group averages but also by considering individual variability.

Nevertheless, some methodological limitations should be taken into account when interpreting the findings. The relatively small sample size may restrict the generalizability of the results. Furthermore, the study only addressed selected neuromuscular parameters, potentially overlooking other components of athletic performance. Including additional motoric attributes such as agility, reaction time, and balance in future studies would provide a more comprehensive understanding of sport-specific differences. That said, the use of consistent methodology and direct comparisons within this study enhances the reliability of the findings.
The results offer practical implications for training design, performance assessment, and talent identification processes. Coaches and performance specialists must evaluate athletes' physical profiles according to sport-specific demands and design individualized training programs accordingly. For example, strength and endurance training for the lower body may be prioritized in football, while upper body strength and anaerobic

 

power development may be more critical in handball. Furthermore, the test batteries used for talent selection and player development tracking should align with the structural and physiological demands of each sport.

## CONCLUSIONS

The present findings highlight distinct physical performance patterns between elite football and handball players, reflecting the sport-specific physiological and biomechanical demands of each discipline. The superior upper body strength observed in handball players aligns with the sport's emphasis on throwing, physical contact, and upper limb coordination, whereas the enhanced lower limb strength in football players may stem from the sport's running-intensive nature and technical demands. Despite these differences, similar outcomes in sprint time, vertical jump, and power output suggest overlapping training effects and convergent adaptations in explosive performance capacities. These observations reinforce the importance of tailoring training and assessment protocols to the unique requirements of each sport. Moreover, while group-level comparisons are informative, individual variability should not be overlooked, especially in high-performance settings. Future research should incorporate broader performance metrics and larger, more diverse samples to deepen our understanding of how anthropometric and neuromuscular attributes interact within and across sporting disciplines.

## AUTHOR CONTRIBUTIONS

Conceptualization, Z.I.K., I.I., P.B.; methodology, Z.I.K., I.I.; software, P.B.; validation, Z.I.K., I.I.; formal analysis, Z.I.K.; investigation, I.I.; resources, P.B.; data curation, P.B.; writing—original draft preparation, Z.I.K., I.I., P.B.; writing—review and editing, Z.I.K.; visualization, P.B.; supervision, Z.I.K., I.I.; project administration, Z.I.K.; funding acquisition, P.B. All authors have read and agreed to the published version of the manuscript.

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## DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

## INSTITUTIONAL REVIEW BOARD STATEMENT

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Duzce University (approval number: 2025/74; date: 27.02.2025).

## INFORMED CONSENT STATEMENT

Informed consent was obtained from all subjects who were involved in this study.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request and with a valid justification.

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