



The Relationship of Isokinetic Lower Limb Strengths of Elite Football Players with Their Playing Positions Before The Preparation Period

“Elit Futbolcuların İzokinetik Alt Ekstremitte Güçlerinin Hazırlık Dönemi Öncesindeki Oyun Pozisyonlarıyla İlişkisi”

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Ethical

This study follows all ethical practices during writing.

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ABSTRACT

Aim: The aim of the study is to determine whether isokinetic lower limb strength parameters of football players during pre-season preparation period are related to their playing positions.

Material and Methods: A total of 19 professional male football players competing in the Turkish Football Federation Super League voluntarily participated in this study. The maximal strength of the participants' knee extensor and flexor muscles was assessed using an isokinetic dynamometer (Cybex NORM®, Humac, CA, USA), which enables the measurement of real-time isokinetic torque. Concentric strength tests of the knee flexors and extensors were performed at two angular velocities: 60°/s and 300°/s. To ensure familiarization with the testing protocol, participants completed four preliminary repetitions at each testing speed. During these repetitions, they were instructed to progressively increase their perceived effort to 25%, 50%, 75%, and 100%. Following the familiarization phase, a rest period of 10 seconds was provided prior to the actual isokinetic testing. Data were analysed using Pearson correlation analysis, and all statistical procedures were conducted using SPSS version 24.0.

Results: A strong positive correlation was observed between the right and left knee flexion values of defensive players at both 60°/s and 300°/s, indicating bilateral strength symmetry. In contrast, midfielders due to their more continuous sprinting efforts—tend to display different loading patterns than defenders or forwards.

Conclusions: Assessing isokinetic strength levels at the start of the preparation period and implementing appropriate training programs may help reduce injury risk and enhance individual performance.

Keywords: Elite Football Players, Isokinetic Lower Limb Strength, Positions.

ÖZET

Amaç: Bu çalışmanın amacı, futbolcuların sezon öncesi hazırlık döneminde izokinetik alt ekstremitte kuvvet parametrelerinin oyun pozisyonlarıyla ilişkili olup olmadığını belirlemektir.

Materyal ve Metod: Türkiye Futbol Federasyonu Süper Ligi'nde yarışan toplam 19 profesyonel erkek futbolcu bu çalışmaya gönüllü olarak katıldı. Katılımcıların diz ekstansör ve fleksör kaslarının maksimum gücü, gerçek zamanlı izokinetik tork ölçümüne olanak tanıyan bir izokinetik dinamometre (Cybex NORM®, Humac, CA, ABD) kullanılarak değerlendirildi. Diz fleksör ve ekstansör kaslarının konsantrik kuvvet testleri iki açışal hızda gerçekleştirildi: 60°/s ve 300°/s. Test protokolüne alışmak için katılımcılar her test hızında dört ön tekrar yaptılar. Bu tekrarlar sırasında, algıladıkları eforu kademeli olarak %25, %50, %75 ve %100'e çıkarmaları istendi. Alışma aşamasının ardından, gerçek izokinetik testten önce 10 saniyelik bir dinlenme süresi verildi. Veriler Pearson korelasyon analizi kullanılarak analiz edildi ve tüm istatistiksel prosedürler SPSS 24.0 sürümü kullanılarak gerçekleştirildi.

Bulgular: Defans oyuncularının sağ ve sol diz fleksiyon değerleri arasında hem 60°/s hem de 300°/s hızlarda güçlü bir pozitif korelasyon gözlemlenmiştir, bu da iki taraflı kuvvet simetrisi olduğunu göstermektedir. Buna karşın, orta saha oyuncuları daha sürekli sprint çabaları nedeniyle defans veya forvetlerden farklı yüklem modelleri sergileme eğilimindedir.

Sonuç: Hazırlık döneminin başında izokinetik kuvvet seviyelerini değerlendirmek ve uygun antrenman programları uygulamak, sakatlık riskini azaltmaya ve bireysel performansı artırmaya yardımcı olabilir.

Anahtar Kelimeler: Elit Futbolcular, İzokinetik Alt Ekstremitte Kuvveti, Pozisyonlar.

INTRODUCTION

The successful performance of a football player during matches is influenced by tactical, technical, mental, and physical attributes. Although the physical demands of football have increased in recent years and aerobic metabolism predominantly governs match play, high-intensity actions such as jumping, accelerating, decelerating, passing, and shooting play a decisive role in determining game outcomes (Delvaux et al., 2023). Therefore, identifying the strength characteristics underlying these actions is critically important not only for enhancing performance but also for reducing injury risk.

These movements largely depend on lower limb muscle strength, and it has been demonstrated that players with higher strength levels have a distinct advantage in sprinting, turning, and change-of-direction performance (Tereso et al., 2021). Accordingly, lower limb strength and anaerobic capacity are key determinants of a player's ability to perform explosive actions at a high level (Delvaux et al., 2023; Tsiokanos et al., 2016). For this reason, conducting performance assessments during the pre-season period is essential to determine players' physical and physiological status and to design individualized training programs (Delvaux et al., 2023; Nobari et al., 2022). Such assessments are also considered crucial for minimizing injury risk and ensuring optimal readiness for the competitive season.

In this context, the isokinetic assessment of muscle strength represents one of the most reliable and widely used methods in football, typically conducted using an isokinetic dynamometer (Creswell et al., 2018). These tests allow for the evaluation of strength and balance between the hamstring and quadriceps muscle groups, as well as the identification of bilateral asymmetries (Kabacinski et al., 2022). Moreover, isokinetic assessments provide valuable information for coaches and performance specialists to establish strength profiles of players, which supports both individualized training prescription and injury prevention strategies.

On the other hand, the physical and physiological demands of football vary according to playing positions (Izovska et al., 2022). Accordingly, muscle strength characteristics and asymmetries may differ based on positional roles (Akyüz et al., 2020). Previous studies have indicated that defenders, midfielders, and forwards may exhibit distinct strength profiles (Śliwowski et al., 2017; Çolak, 2020). These findings emphasize the importance of considering positional differences when developing position-specific training and conditioning programs.

Based on this framework, determining the lower limb strength profiles of football players during the pre-season period is expected to contribute to more effective and individualized training planning. Although previous studies have examined isokinetic lower limb strength in football players, research directly focusing on positional differences remains limited. Therefore, the present study aims to analyze the relationship between lower limb strength profiles and playing positions in elite football players. It is hypothesized that significant differences exist in isokinetic lower limb strength profiles according to playing positions, and that these differences may inform the development of position-specific training strategies.

MATERIAL AND METHOD

Research Model

The model used in the study was the correlational survey model. Correlational survey models are said to be research models that aim to determine the presence and/or degree of change between two or more variables. Although the correlational survey model does not give a real cause-effect relationship, it is known that if the situation in the variable is known, it allows the other variable to be predicted (Karasar, 2006).

Sample Group

A total of 19 professional male football players competing in the Turkish Football Federation Super League voluntarily participated in the study, including defenders ($n = 7$), midfielders ($n = 7$), and forwards ($n = 5$). Detailed information regarding the test protocols was provided to the players, and informed consent forms were obtained. All tests were conducted during the pre-season period. It should be noted that the relatively small sample size, particularly in the forward group ($n = 5$), may limit the generalizability of the findings. The study was conducted in accordance with the principles of the Declaration of Helsinki (Revised in 2013) and approved by the Ethics Committee of Istanbul Gelişim University (Approval No: 2024-02).

Participants were instructed to refrain from engaging in strenuous exercise at least 24 hours prior to testing. On the test day, they were asked not to consume caffeine or any stimulants. It was verbally confirmed that none of the players had any musculoskeletal injuries or pain during the testing period.

Study Design

This research employed a cross-sectional and comparative design conducted during the pre-season preparation period. The study evaluated the isokinetic strength characteristics of the lower extremities in football players and analyzed the positional differences as well as the relationships among muscle strength parameters. Measurements were performed on the scheduled test days without interfering with the players' training programs. All tests were carried out in a controlled laboratory environment under standardized conditions (temperature 22–24°C, humidity 40–50%, and in the morning hours).

Measurements

Body Weight and Height Measurement: While weight of the participants was measured using an electronic balance with an accuracy of 0.1 kg, their height was measured using a digital height meter with an accuracy of 0.01 cm (Zorba, 1999).

Isokinetic Strength Test: The maximum strength of the knee extensor and flexor muscles of the participants was measured using an isokinetic dynamometer device (Cybex NORM®, Humac, CA, USA) that allows the recording of instantaneous isokinetic torque (Impellizzeri et al., 2008). The range of motion during testing was set using 100° knee flexion with voluntary maximal full extension (0°). Before the start of the test, the limbs of the subjects were locked by the machine in the minimal knee flexion position and the subjects were asked to completely relax their legs to determine the passive effects of gravity on the limb. A fixed test sequence was established. The concentric power of the knee flexors and extensors was tested at two speeds, first at 60° per second and then at 300° per second. To familiarize with the testing protocol, the subjects completed four repetitions at each isokinetic speed before the actual test. At each repetition, they were asked to increase their perceived effort (25%, 50%, 75%, 100% effort). After the exercise set, a ten-second rest time was given before the isokinetic test began. The subjects completed five continuous repetitions of knee flexion and extension at a maximum effort of 60° per second. Subsequently, the subjects completed fifteen continuous repetitions of knee flexion and extension at 300° per second. During all tests, the clinician verbally encouraged the subjects to perform maximal effort and they were allowed to view the computer monitor during the test for feedback. The setup and test protocol were repeated on the contralateral leg. Verbal prompts and motivations were provided throughout the tests to allow the participants to maximize their strength values. The test position was performed as recommended in the manufacturer's manual (McPherson et al., 2023).

Statistical Analysis

The data obtained in the study were transferred to an electronic medium and presented as mean \pm standard deviation and 95% confidence intervals (CI). For the normality test, skewness and kurtosis values were examined using the Shapiro–Wilk test. Pearson correlation analysis was applied to the data that showed a normal distribution. To examine the differences between playing positions, a one-way ANOVA was conducted and effect sizes (η^2) were calculated. In addition, post-hoc power analysis was performed using the G*Power software to determine the statistical power of the correlation and ANOVA analyses. The results indicated that the statistical power of the Pearson correlation analyses ranged

between 0.78 and 0.92 (78–92%), while the statistical power of the one-way ANOVA was calculated as 0.81 (81%). These findings suggest that the study had sufficient power to detect medium to large effect sizes. All statistical analyses were conducted using the SPSS (version 24) software (McPherson et al., 2023).

RESULTS

Table 1. Analysis of Descriptive Demographic Parameters of the Football Players

| Variables | N | Min. | Max. | X+Sd |
|--------------------------|----|--------|--------|-------------|
| Age (years) | 19 | 18.00 | 32.00 | 22.89±4.65 |
| Height (cm) | 19 | 174.00 | 190.00 | 181.26±4.65 |
| Body weight (kg) | 19 | 66.00 | 83.00 | 75.57±5.28 |
| BMI (kg/m ²) | 19 | 21.04 | 25.62 | 22.99±1.20 |

Table 1 shows the mean ages of the football players in the study. Their mean age was 22.89±4.65, their height was 181.26±4.65, their body weight was 75.57±5.28 and BMI (kg/m²) was 22.99±1.20.

Table 2a. Isokinetic force values of football players by position at an angular velocity of 60°/s ($\bar{X} \pm Ss$, 95% CI)

| Variables | Defensive (n=7) | 95% CI (Lower-Upper) | Midfield (n=7) | 95% CI (Lower-Upper) | Forward (n=5) | 95% CI (Lower-Upper) |
|-----------------------------------|-----------------|----------------------|----------------|----------------------|----------------|----------------------|
| Flexion Right 60°/s (Nm) | 259.71 ± 18.34 | 242.75-276.67 | 242.71 ± 27.67 | 217.11-268.30 | 251.80 ± 30.73 | 213.64-289.95 |
| Flexion Right 60°/s B/W (Nm/kg) | 337.71 ± 19.15 | 320.00-355.42 | 322.43 ± 19.16 | 304.70-340.15 | 339.20 ± 43.36 | 285.36-393.03 |
| Flexion Left 60°/s (Nm) | 234.57 ± 16.12 | 219.66-249.48 | 219.14 ± 25.10 | 195.92-242.35 | 237.60 ± 25.70 | 205.69-269.50 |
| Flexion Left 60°/s B/W (Nm/kg) | 304.43 ± 14.54 | 290.98-317.87 | 292.00 ± 22.85 | 270.86-313.13 | 320.20 ± 34.11 | 277.84-362.55 |
| Extension Right 60°/s (Nm) | 150.43 ± 16.31 | 135.34-165.51 | 152.86 ± 18.66 | 135.60-170.11 | 146.80 ± 11.52 | 132.49-161.10 |
| Extension Right 60°/s B/W (Nm/kg) | 195.71 ± 18.56 | 178.54-212.88 | 203.43 ± 18.85 | 185.99-220.86 | 198.20 ± 15.39 | 179.09-217.30 |
| Extension Left 60°/s (Nm) | 146.71 ± 10.67 | 136.84-156.58 | 146.29 ± 26.08 | 122.16-170.40 | 137.80 ± 7.19 | 128.87-146.72 |
| Extension Left 60°/s B/W (Nm/kg) | 191.86 ± 15.46 | 177.55-206.15 | 194.71 ± 25.82 | 170.83-218.59 | 186.20 ± 11.34 | 172.11-200.28 |
| H/Q Right 60°/s (%) | 57.86 ± 4.67 | 53.53-62.17 | 62.86 ± 2.73 | 60.32-65.38 | 58.60 ± 4.16 | 53.43-63.76 |
| H/Q Left 60°/s (%) | 61.29 ± 4.99 | 56.67-65.90 | 66.43 ± 7.76 | 59.24-73.60 | 58.20 ± 5.50 | 51.37-65.60 |

Table 2a. Examination of the results indicates that, at an angular velocity of 60°/s, the isokinetic lower limb strength values of the participating football players showed similar mean torque values across playing positions. However, the H/Q ratios were found to be higher in midfielders and forwards compared to defenders.

Table 2b. Isokinetic force values at 300°/s angular velocity according to player positions ($\bar{X} \pm Ss$, 95% CI)

| Variables | Defensive (n=7) | 95% CI (Lower-Upper) | Midfield (n=7) | 95% CI (Lower-Upper) | Forward (n=5) | 95% CI (Lower-Upper) |
|----------------------------------|-----------------|----------------------|----------------|----------------------|----------------|----------------------|
| Flexion Right 300°/s (Nm) | 133.43 ± 11.70 | 122.60-144.25 | 125.00 ± 15.15 | 110.98-139.01 | 126.80 ± 14.24 | 109.12-144.47 |
| Flexion Right 300°/s B/W (Nm/kg) | 173.43 ± 10.31 | 163.89-182.96 | 166.14 ± 17.30 | 150.14-182.13 | 171.20 ± 21.70 | 144.26-198.13 |
| Flexion Left 300°/s (Nm) | 124.57 ± 10.15 | 115.18-133.95 | 116.00 ± 17.77 | 99.56-132.43 | 131.60 ± 25.50 | 99.93-163.26 |
| Flexion Left 300°/s B/W | 162.29 ± 7.52 | 155.32-169.24 | 154.14 ± 19.57 | 136.03-172.24 | 176.60 ± 33.57 | 134.92-218.28 |

| | | | | | | |
|------------------------------------|----------------|--------------|----------------|---------------|----------------|---------------|
| (Nm/kg) | | | | | | |
| Extension Right 300°/s (Nm) | 83.43 ± 15.80 | 68.81-98.04 | 85.86 ± 15.31 | 71.69-100.01 | 93.20 ± 14.96 | 74.62-111.77 |
| Extension Right 300°/s B/W (Nm/kg) | 108.71 ± 20.26 | 89.97-127.45 | 113.43 ± 14.12 | 100.37-126.48 | 125.60 ± 21.78 | 98.55-152.64 |
| Extension Left 300°/s (Nm) | 85.57 ± 15.25 | 71.46-99.67 | 85.29 ± 10.72 | 75.37-95.19 | 88.80 ± 7.79 | 79.12-98.47 |
| Extension Left 300°/s B/W (Nm/kg) | 110.86 ± 18.95 | 93.33-128.38 | 113.00 ± 10.82 | 102.99-123.00 | 118.40 ± 4.93 | 112.27-124.52 |
| H/Q Right 300°/s (%) | 62.29 ± 9.36 | 53.63-70.94 | 68.57 ± 7.32 | 61.79-75.34 | 73.40 ± 5.68 | 66.34-80.45 |
| H/Q Left 300°/s (%) | 69.00 ± 11.83 | 58.05-79.94 | 73.86 ± 5.15 | 69.09-78.61 | 69.40 ± 12.74 | 53.58-85.21 |

Table 2b. Examination of the data reveals that, at an angular velocity of 300°/s, the isokinetic lower limb strength values of football players showed generally similar mean torque values across playing positions. In terms of flexion, defenders and forwards produced relatively higher strength compared to midfielders, whereas in extension, forwards demonstrated higher mean values than both defenders and midfielders.

Table 3. Comparison of Isokinetic Force Values at Angular Velocities of 60°/s and 300°/s According to the Players' Positions

| Variables | F | p | η² | Pairwise Comparison |
|------------------------------------|-------|-------|-------|---------------------|
| Flexion Right 60°/s (Nm) | .780 | 0.475 | 0.089 | - |
| Flexion Right 60°/s B/W (Nm/kg) | .755 | 0.486 | 0.086 | - |
| Flexion Left 60°/s (Nm) | 1.261 | 0.310 | 0.136 | - |
| Flexion Left 60°/s B/W (Nm/kg) | 2.051 | 0.161 | 0.204 | - |
| Extension Right 60°/s (Nm) | .203 | 0.818 | 0.025 | - |
| Extension Right 60°/s B/W (Nm/kg) | .335 | 0.721 | 0.040 | - |
| Extension Left 60°/s (Nm) | .450 | 0.646 | 0.053 | - |
| Extension Left 60°/s B/W (Nm/kg) | .287 | 0.754 | 0.035 | - |
| H/Q Right 60°/s (%) | 3.230 | 0.066 | 0.288 | - |
| H/Q Left 60°/s (%) | 2.665 | 0.100 | 0.250 | - |
| Flexion Right 300°/s (Nm) | .718 | 0.503 | 0.082 | - |
| Flexion Right 300°/s B/W (Nm/kg) | .358 | 0.704 | 0.043 | - |
| Flexion Left 300°/s (Nm) | 1.140 | 0.344 | 0.125 | - |
| Flexion Left 300°/s B/W (Nm/kg) | 1.654 | 0.222 | 0.171 | - |
| Extension Right 300°/s (Nm) | .612 | 0.555 | 0.071 | - |
| Extension Right 300°/s B/W (Nm/kg) | 1.232 | 0.318 | 0.133 | - |
| Extension Left 300°/s (Nm) | .145 | 0.866 | 0.018 | - |
| Extension Left 300°/s B/W (Nm/kg) | .461 | 0.639 | 0.055 | - |
| H/Q Right 300°/s (%) | 3.051 | 0.075 | 0.276 | - |
| H/Q Left 300°/s (%) | .474 | 0.631 | 0.056 | - |

Table 3. Upon examination, no statistically significant differences were found in the isokinetic knee flexion and extension strength values or H/Q ratios among football players competing in different positions (defenders, midfielders, and forwards) ($p > 0.05$). However, although effect sizes calculated for the H/Q ratios at 60°/s angular velocity ($\eta^2 = 0.25-0.28$) were found to be of moderate magnitude, no statistically significant differences were observed.

Table 4. Correlation Analysis of 600/s Flexion and Extension Right-Left Isokinetic Lower Limb Strength of the Defensive Players

| Positions | Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---------------------------------|-----------|-------|-------|---|---|---|---|---|---|---|----|
| Flexion Right 60°/s (Nm) | r | 1 | | | | | | | | | |
| | p | | | | | | | | | | |
| Flexion Right B/W 60°/s (Nm/kg) | r | 0.612 | 1 | | | | | | | | |
| | p | 0.144 | | | | | | | | | |
| Flexion Left 60°/s (Nm) | r | .794* | 0.536 | 1 | | | | | | | |
| | p | 0.033 | 0.215 | | | | | | | | |

| | | | | | | | | | | | | |
|-----------|---------------------------------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|
| Defensive | Flexion Left B/W 60°/s(Nm/kg) | r | 0.445 | 0.424 | 0.637 | 1 | | | | | | |
| | | p | 0.317 | 0.343 | 0.124 | | | | | | | |
| | Extension Right 60°/s(Nm) | r | 0.656 | 0.121 | 0.355 | -0.003 | 1 | | | | | |
| | | p | 0.110 | 0.796 | 0.434 | 0.995 | | | | | | |
| | Extension Right B/W60°/s(Nm/kg) | r | 0.362 | -0.093 | -0.042 | 0.036 | .841* | 1 | | | | |
| | | p | 0.426 | 0.844 | 0.928 | 0.939 | 0.018 | | | | | |
| | Extension Left 60°/s(Nm) | r | 0.577 | 0.503 | .786* | .913** | 0.287 | 0.185 | 1 | | | |
| | | p | 0.175 | 0.250 | 0.036 | 0.004 | 0.532 | 0.692 | | | | |
| | Extension Left B/W 60°/s(Nm/kg) | r | 0.126 | 0.255 | 0.260 | .872* | -0.016 | 0.234 | .789* | 1 | | |
| | | p | 0.787 | 0.581 | 0.573 | 0.010 | 0.974 | 0.613 | 0.035 | | | |
| | H/Q Right 60°/s | r | 0.052 | -0.375 | -0.171 | -0.375 | .787* | .811* | -0.101 | -0.143 | 1 | |
| | | p | 0.912 | 0.407 | 0.713 | 0.408 | 0.036 | 0.027 | 0.829 | 0.759 | | |
| | H/Q Left 60°/s | r | -0.057 | -0.060 | -0.148 | 0.449 | -0.356 | -0.024 | 0.099 | 0.453 | -0.433 | 1 |
| | | p | 0.904 | 0.899 | 0.752 | 0.312 | 0.433 | 0.959 | 0.833 | 0.307 | 0.332 | |

Table 4 shows the correlation analyses of 60°/s flexion and extension right-left isokinetic lower limb strength of the defensive players in the study. While a high positive correlation was found between flx right 600/s and flx left 600/s (r=.794; p=0.033), flx left 600/s and ext left 600/s (r=.786; p=0.036), flx left B/W 600/s and ext left B/W 600/s (r=.872; p=0.010), ext right 600/s and ext right B/W 600/s (r=.841; p=0.018), ext. right B/W 600/s and H/Q right 600/s (r=.811; p=0.027), ext. right 600/s and H/Q right 600/s (r=.787; p=0.036) and ext left 600/s and ext left B/W 600/s (r=.789; p=0.035) values, a very high positive correlation was observed between flx left B/W 600/s and ext left 600/s (r=.913; p=0.004) values.

Table 5. Correlation Analyses of 600/s Flexion and Extension Right-Left Isokinetic Lower Limb Strength of Midfield Players

| Positions | Variables | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----------------|----------------------------------|--------------|---------------|----------------|---------------|---------------|--------------|---------------|--------------|---------------|----------|----|
| Midfield | Flexion Right 60°/s(Nm) | r | 1 | | | | | | | | | |
| | | p | | | | | | | | | | |
| | Flexion Right B/W 60°/s(Nm/kg) | r | 0.511 | 1 | | | | | | | | |
| | | p | 0.241 | | | | | | | | | |
| | Flexion Left 60°/s(Nm) | r | .949** | 0.591 | 1 | | | | | | | |
| | | p | 0.001 | 0.162 | | | | | | | | |
| | Flexion Left B/W60°/s(Nm/kg) | r | 0.299 | .884** | 0.514 | 1 | | | | | | |
| | | p | 0.515 | 0.008 | 0.238 | | | | | | | |
| | Extension Right 60°/s(Nm) | r | .940** | 0.670 | .939** | 0.501 | 1 | | | | | |
| | | p | 0.002 | 0.100 | 0.002 | 0.252 | | | | | | |
| | Extension Right B/W 60°/s(Nm/kg) | r | 0.342 | 0.921** | 0.455 | .881** | 0.604 | 1 | | | | |
| | | p | 0.453 | 0.003 | 0.305 | 0.009 | 0.151 | | | | | |
| | Extension Left 60°/s(Nm) | r | .863* | 0.492 | .774* | 0.223 | .805* | 0.325 | 1 | | | |
| | | p | 0.012 | 0.262 | 0.041 | 0.630 | 0.029 | 0.477 | | | | |
| | Extension Left B/W 60°/s(Nm/kg) | r | 0.566 | 0.674 | 0.516 | 0.426 | 0.604 | 0.551 | .861* | 1 | | |
| | | p | 0.186 | 0.097 | 0.235 | 0.340 | 0.151 | 0.200 | 0.013 | | | |
| H/Q Right 60°/s | r | 0.021 | 0.545 | 0.173 | 0.656 | 0.359 | .826* | -0.009 | 0.198 | 1 | | |
| | p | 0.964 | 0.206 | 0.711 | 0.109 | 0.429 | 0.022 | 0.985 | 0.671 | | | |
| H/Q Left 60°/s | r | 0.443 | 0.207 | 0.260 | -0.132 | 0.357 | 0.067 | .812* | .840* | -0.193 | 1 | |
| | p | 0.320 | 0.656 | 0.573 | 0.777 | 0.432 | 0.887 | 0.026 | 0.018 | 0.679 | | |

Table 5 shows the correlation analyses of 600/s flexion and extension right-left isokinetic lower limb strength of the midfield players in the study. A very high positive correlation was observed between flx right 600/s and ext left 600/s (r=.863; p=0.012), flx right B/W 600/s and flx left B/W 600/s (r=.884; p=0.008), flx left 600/s and ext left 600/s (r=.774; p=0.041), flx left B/W 600/s and ext right B/W 600/s (r=.881; p=0.009), ext right 600/s and ext left 600/s (r=.805; p=0.029), ext right B/W 600/s and H/Q right 600/s (r=.826; p=0.022), ext left 600/s and ext left B/W 600/s (r=.861; p=.013), ext left 600/s and H/Q left 600/s (r=.812; p=0.026), ext left B/W 600/s and H/Q left 600/s (r=.840; p=0.018) values. Moreover, A very high positive correlation was detected in flx right 600/s and flx left 600/s (r=.949; p=0.001), flx right 600/s and ext right 600/s (r=.940; p=0.002), flx right 600/s and ext right B/W 600/s (r=.921; p=0.003) and flx left 600/s and ext right 600/s (r=.939; p=0.002) values.

Table 6. Correlation Analyses of 600/s Flexion and Extension Right-Left Isokinetic Lower Limb Strength of Forward Players

| Positions | Variables | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|-----------------------------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|---|----|--|
| Forward | Flexion Right 60 ⁰ /s(Nm) | r | 1 | | | | | | | | | | |
| | | p | | | | | | | | | | | |
| | Flexion Right B/W 60 ⁰ /s(Nm/kg) | r | .915* | 1 | | | | | | | | | |
| | | p | 0.029 | | | | | | | | | | |
| | Flexion Left 60 ⁰ /s(Nm) | r | .903* | 0.729 | 1 | | | | | | | | |
| | | p | 0.036 | 0.162 | | | | | | | | | |
| | Flexion Left B/W 60 ⁰ /s(Nm/kg) | r | .890* | .916* | 0.878 | 1 | | | | | | | |
| | | p | 0.043 | 0.029 | 0.050 | | | | | | | | |
| | Extension Right 60 ⁰ /s(Nm) | r | 0.840 | 0.674 | 0.802 | 0.674 | 1 | | | | | | |
| | | p | 0.075 | 0.212 | 0.103 | 0.212 | | | | | | | |
| | Extension Right B/W 60 ⁰ /s(Nm/kg) | r | 0.762 | 0.868 | 0.595 | 0.794 | 0.780 | 1 | | | | | |
| | | p | 0.134 | 0.057 | 0.290 | 0.109 | 0.119 | | | | | | |
| | Extension Left 60 ⁰ /s(Nm) | r | 0.298 | 0.097 | 0.445 | 0.231 | -0.058 | -0.357 | 1 | | | | |
| | | p | 0.626 | 0.876 | 0.453 | 0.709 | 0.926 | 0.556 | | | | | |
| | Extension Left B/W 60 ⁰ /s(Nm/kg) | r | 0.151 | 0.349 | 0.105 | 0.367 | -0.394 | -0.049 | 0.528 | 1 | | | |
| | | p | 0.808 | 0.565 | 0.867 | 0.543 | 0.512 | 0.938 | 0.361 | | | | |
| | H/Q Right 60 ⁰ /s | r | -0.768 | -0.862 | -0.612 | -0.799 | -0.305 | -0.506 | -0.480 | -0.734 | 1 | | |
| | | p | 0.130 | 0.060 | 0.272 | 0.105 | 0.618 | 0.384 | 0.413 | 0.158 | | | |
| H/Q Left 60 ⁰ /s | r | -0.861 | -0.791 | -0.853 | -0.850 | -.939* | -.891* | 0.084 | 0.176 | 0.442 | 1 | | |
| | p | 0.061 | 0.111 | 0.066 | 0.068 | 0.018 | 0.043 | 0.894 | 0.778 | 0.456 | | | |

Table 6 shows the correlation analyses of 600/s flexion and extension right-left isokinetic lower limb strength of the forward players in the study. While there was a very high correlation between flx right 600/s and flx right B/W 600/s ($r=.915$; $p=0.029$), flx left 600/s ($r=.903$; $p= 0.036$) of the football players and a very high correlation in flx Left B/W 600/s ($r=.890$; $p=0.043$), a very high correlation was found between flx right B/W 600/s and flx Left B/W 600/s ($r=.916$; $p= 0.029$). A very high negative correlation between Ext right 600/s and H/Q left 600/s ($r=-.939$; $p=0.018$) and a very high negative correlation between ext. right B/W 600/s and H/Q left 600/s ($r=-.891$; $p=0.043$) were found.

Table 7. Correlation Analysis of 3000/s Flexion and Extension Right-Left Isokinetic Lower Limb Strength of Defensive Players

| Positions | Variables | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|------------------------------|--|-------|-------|--------|--------|-------|--------|--------|--------|-------|---|----|--|
| Defensive | Flexion Right 300 ⁰ /s(Nm) | r | 1 | | | | | | | | | | |
| | | p | | | | | | | | | | | |
| | Flexion Right B/W 300 ⁰ /s(Nm/kg) | r | .806* | 1 | | | | | | | | | |
| | | p | 0.028 | | | | | | | | | | |
| | Flexion Left 300 ⁰ /s(Nm) | r | 0.608 | 0.165 | 1 | | | | | | | | |
| | | p | 0.147 | 0.724 | | | | | | | | | |
| | Flexion Left B/W 300 ⁰ /s(Nm/kg) | r | 0.169 | 0.030 | 0.749 | 1 | | | | | | | |
| | | p | 0.718 | 0.948 | 0.053 | | | | | | | | |
| | Extension Right 300 ⁰ /s(Nm) | r | 0.600 | 0.696 | 0.394 | 0.466 | 1 | | | | | | |
| | | p | 0.154 | 0.083 | 0.381 | 0.292 | | | | | | | |
| | Extension Right B/W 300 ⁰ /s(Nm/kg) | r | 0.376 | 0.642 | 0.123 | 0.367 | .950** | 1 | | | | | |
| | | p | 0.406 | 0.120 | 0.792 | 0.418 | 0.001 | | | | | | |
| | Extension Left 300 ⁰ /s(Nm) | r | 0.716 | .771* | 0.401 | 0.376 | .932** | .847* | 1 | | | | |
| | | p | 0.070 | 0.042 | 0.372 | 0.406 | 0.002 | 0.016 | | | | | |
| | Extension Left B/W 300 ⁰ /s(Nm/kg) | r | 0.487 | 0.735 | 0.096 | 0.254 | .897** | .921** | .939** | 1 | | | |
| | | p | 0.267 | 0.060 | 0.838 | 0.582 | 0.006 | 0.003 | 0.002 | | | | |
| | H/Q Right 300 ⁰ /s | r | 0.192 | 0.423 | 0.116 | 0.427 | .899** | .965** | 0.747 | .836* | 1 | | |
| | | p | 0.680 | 0.344 | 0.805 | 0.339 | 0.006 | 0.000 | 0.054 | 0.019 | | | |
| H/Q Left 300 ⁰ /s | r | 0.451 | 0.750 | -0.130 | -0.045 | .782* | .836* | .854* | .954** | 0.730 | 1 | | |
| | p | 0.309 | 0.052 | 0.780 | 0.924 | 0.038 | 0.019 | 0.014 | 0.001 | 0.062 | | | |

Table 7 shows the correlation analyses of 3000/s flexion and extension right-left isokinetic lower limb strength of the defensive players in the study. While a high correlation was found between flx right 3000/s and flx right B/W 3000/s ($r=.806$; $p=0.028$) and flx right B/W 3000/s and ext left 3000/s ($r=.771$; $p=0.042$), ext right 3000/s and ext. left B/W 3000/s ($r=.897$; $p=0.006$), H/Q left 3000/s ($r=.782$; $p=0.038$), H/Q Right 3000/s ($r=.899$; $p=0.006$) and ext. Right B/W 3000/s and ext. Left 3000/s ($r=.847$; $p=0.016$), H/Q left 3000/s ($r=.836$; $p=0.019$), ext. left 3000/s and H/Q left 3000/s ($r=.854$; $p=0.014$), ext.

left B/W 3000/s and H/Q right 3000/s ($r=.836$; $p=0.019$) of the football players, a very high correlation was seen between ext right 3000/s and ext. right B/W 3000/s ($r=.950$; $p=0.001$), ext. right B/W 3000/s and ext. left B/W 3000/s ($r=.921$; $p=0.003$), ext right 3000/s and ext left 3000/s ($r=.932$; $p=0.002$), H/Q right 3000/s ($r=.965$; $p=0.000$), ext. left 3000/s and ext. left B/W 3000/s ($r=.939$; $p=0.002$) and ext. left B/W 3000/s and H/Q left 3000/s ($r=.954$; $p=0.001$) parameters.

Table 8. Correlation Analyses of 3000/s Flexion and Extension Right-Left Isokinetic Lower Limb Strength of Midfield Players

| Positions | Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------------|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|----|
| Midfield | Flexion Right 300 ⁰ /s(Nm) | r | 1 | | | | | | | | |
| | | p | | | | | | | | | |
| | Flexion Right B/W 300 ⁰ /s(Nm/kg) | r | 0.610 | 1 | | | | | | | |
| | | p | 0.145 | | | | | | | | |
| | Flexion Left 300 ⁰ /s(Nm) | r | .984** | 0.613 | 1 | | | | | | |
| | | p | 0.000 | 0.143 | | | | | | | |
| | Flexion Left B/W 300 ⁰ /s(Nm/kg) | r | 0.705 | .972** | 0.736 | 1 | | | | | |
| | | p | 0.077 | 0.000 | 0.059 | | | | | | |
| | Extension Right 300 ⁰ /s(Nm) | r | .756* | 0.226 | .789* | 0.370 | 1 | | | | |
| | | p | 0.049 | 0.626 | 0.035 | 0.414 | | | | | |
| | Extension Right B/W300 ⁰ /s(Nm/kg) | r | 0.596 | 0.549 | 0.662 | 0.642 | .826* | 1 | | | |
| | | p | 0.158 | 0.202 | 0.105 | 0.120 | 0.022 | | | | |
| | Extension Left 300 ⁰ /s(Nm) | r | .873* | 0.395 | .874* | 0.523 | 0.540 | 0.283 | 1 | | |
| | | p | 0.010 | 0.380 | 0.010 | 0.228 | 0.210 | 0.538 | | | |
| | Extension Left B/W 300 ⁰ /s(Nm/kg) | r | 0.519 | .786* | 0.539 | .801* | -0.018 | 0.177 | 0.630 | 1 | |
| | | p | 0.233 | 0.036 | 0.212 | 0.031 | 0.969 | 0.704 | 0.130 | | |
| | H/Q Right 300 ⁰ /s | r | 0.114 | -0.292 | 0.191 | -0.160 | 0.735 | 0.636 | -0.053 | -0.530 | 1 |
| | | p | 0.807 | 0.526 | 0.682 | 0.732 | 0.060 | 0.125 | 0.909 | 0.221 | |
| H/Q Left 300 ⁰ /s | r | -0.594 | -0.681 | -0.605 | -0.696 | -0.654 | -.839* | -0.150 | -0.135 | -0.347 | 1 |
| | p | 0.159 | 0.092 | 0.150 | 0.082 | 0.111 | 0.018 | 0.748 | 0.773 | 0.446 | |

Table 8 shows the correlation analyses of 3000/s flexion and extension right-left isokinetic lower limb strength of the midfield players in the study. A high positive correlation was observed between flx right 3000/s and ext right 3000/s ($r=.756$; $p=0.049$), flx right 3000/s and ext left 3000/s ($r=.873$; $p=0.010$), flx right B/W 3000/s and ext left B/W 3000/s ($r=.786$; $p=0.036$), flx left 3000/s and ext right 3000/s ($r=.789$; $p=0.035$), flx left 3000/s and ext left 3000/s ($r=.874$; $p=0.010$), flx left B/W 3000/s and ext left B/W 3000/s ($r=.801$; $p=0.031$), ext right 3000/s and ext right B/W 3000/s ($r=.826$; $p=0.022$) and values of the football players, while a very high positive correlation was found between flx right 3000/s and flx left 3000/s ($r=.984$; $p=0.000$), flx right B/W 3000/s and flx left B/W 3000/s ($r=.972$; $p=0.000$) and ext right 3000/s values and a high negative correlation between ext right B/W 3000/s and H/Q left 3000/s ($r=-.839$; $p=0.018$) was determined.

Table 9. Correlation Analyses of 3000/s Flexion and Extension Right-Left Isokinetic Lower Limb Strength of Forward Players

| Positions | Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|------------------------------|--|--------|--------|--------|---------|---------|--------|--------|--------|--------|----|
| Forward | Flexion Right 300 ⁰ /s(Nm) | r | 1 | | | | | | | | |
| | | p | | | | | | | | | |
| | Flexion Right B/W 300 ⁰ /s(Nm/kg) | r | .921* | 1 | | | | | | | |
| | | p | 0,026 | | | | | | | | |
| | Flexion Left 300 ⁰ /s(Nm) | r | 0.821 | 0.683 | 1 | | | | | | |
| | | p | 0.089 | 0.204 | | | | | | | |
| | Flexion Left B/W 300 ⁰ /s(Nm/kg) | r | 0.871 | 0.830 | .964** | 1 | | | | | |
| | | p | 0.054 | 0.082 | 0.008 | | | | | | |
| | Extension Right 300 ⁰ /s(Nm) | r | 0.870 | 0.870 | .896* | .965** | 1 | | | | |
| | | p | 0.055 | 0.055 | 0.040 | 0.008 | | | | | |
| | Extension Right B/W 300 ⁰ /s(Nm/kg) | r | 0.818 | .917* | 0.772 | .904* | .967** | 1 | | | |
| | | p | 0.091 | 0.028 | 0.126 | 0.035 | 0.007 | | | | |
| | Extension Left 300 ⁰ /s(Nm) | r | 0.024 | -0.358 | 0.193 | -0.057 | -0.208 | -0.441 | 1 | | |
| | | p | 0.969 | 0.555 | 0.755 | 0.928 | 0.737 | 0.457 | | | |
| | Extension Left B/W 300 ⁰ /s(Nm/kg) | r | 0.019 | -0.265 | 0.075 | -0.106 | -0.323 | -0.478 | 0.855 | 1 | |
| | | p | 0.976 | 0.666 | 0.904 | 0.865 | 0.595 | 0.416 | 0.065 | | |
| | H/Q Right 300 ⁰ /s | r | 0.273 | 0.403 | 0.574 | 0.647 | 0.711 | 0.731 | -0.472 | -0.659 | 1 |
| | | p | 0.657 | 0.502 | 0.311 | 0.238 | 0.179 | 0.161 | 0.422 | 0.227 | |
| H/Q Left 300 ⁰ /s | r | -0,837 | -0.846 | -.927* | -.992** | -.970** | -.939* | 0.180 | 0.208 | -0.711 | 1 |
| | p | 0.077 | 0.071 | 0.023 | 0.001 | 0.006 | 0.018 | 0.772 | 0.737 | 0.179 | |

Table 9 shows the correlation analyses of 3000/s flexion and extension right-left isokinetic lower limb strength of the forward players in the study. There was a very high positive correlation between flx right 3000/s and flx right B/W 3000/s ($r=.921$; $p=0.026$), flx right B/W 3000/s and ext right B/W 3000/s ($r=.917$; $p=0.028$), flx left 3000/s and flx left B/W 3000/s ($r=.964$; $p=0.008$), flx left B/W 3000/s and ext right 3000/s ($r=.965$; $p=0.008$), flx left B/W 3000/s and ext right B/W 3000/s ($r=.904$; $p=0.035$), ext right 3000/s and ext right B/W 3000/s ($r=.967$; $p=0.007$) of the football players, there was a high positive correlation between flx left B/W 300 sn and ext right 3000/s ($r=.896$; $p=0.040$) values and a very high negative correlation between flx left 3000/s and H/Q Left 3000/s ($r=-.927$; $p=0.023$), flx left B/W 3000/s and H/Q Left 3000/s ($r=-.992$; $p=0.001$), ext right 3000/s and H/Q Left 3000/s ($r=-.970$; $p=0.006$) and ext right B/W 3000/s and H/Q Left 3000/s ($r=-.939$; $p=0.018$).

DISCUSSION AND CONCLUSION

With the changing game structure of the football branch, the physical and physiological needs of football players vary. Especially when the positions of the football players in the field are considered, the needs of the player profiles in each position also differ. In addition, it is thought that determining the needs of football players according to their positions during the pre-season period and planning the preparation period according to these needs are important for their own performance and team performance. Thus, the study was planned to determine whether or not the isokinetic lower limb strength parameters of football players in the pre-season period are related to their playing positions. In addition, the fact that there are no studies in literature examining the relationship between the isokinetic lower limb strength of football players before the preparation period and their playing positions not only leads to limitations in the discussion section of the current study, but also increases the importance of the study. Furthermore, since there are comparisons in the studies in the literature, it has been used in the discussion section.

When the related studies in the literature were examined, Śliwowski et al., (2017) it was determined that the isokinetic lower limb strength profiles of elite football players according to their playing positions were investigated. The results of the study indicated that the isokinetic strength performances of football players competing in different positions on the field varied according to their positions. In particular, the isokinetic strength performance of goalkeepers was found to be lower than that of football players in other positions. As can be understood from this situation, the individual strength profiles of football players in different field positions vary. Another study Weber et al., (2010) reported that there was a statistically significant difference between the extension and flexion values of defensive players and those in other positions in professional football players (Cosendey et al., 2022). Examined the isokinetic lower limb strength of football players according to positions and found that there were statistically significant differences between the lower limb strength values of football players Atasver and K1Y1C1, (2023) investigated the lower limb isokinetic strength performance of elite football players according to their positions. According to the results of the current study, they reported that there were differences between positions in terms of lower limb strength parameters. Another study Ruas et al., (2015) examining the lower limb strength of football players according to their positions in the field reported that there were differences in strength parameters between the positions of football players. Yılmaz et al., (2019), analyzed the knee strength of football players. According to the results of the study, they found that there was a statistically significant difference between the 600/s right and left extension-flexion parameters of the players in defensive, midfield and forward positions. In another study Çolak, (2020) it was found that there was a statistically significant difference between the forward and defensive groups in the 600/s ankle plantar flexion parameter of football players competing in different positions. In another study conducted in the past years Meriç et al., (2007) the isokinetic performance of football players according to their playing positions was compared. According to the results obtained from the current study, they stated that there was a statistically significant difference between the positions in 600/s values. Silva et al., (2015) conducted a study on elite youth football players and found that the extensor knee eccentric torque values of defensive players were statistically higher than those of midfielders. This may be due to the fact that defensive players are exposed to more high intensity actions during the competition than midfielders.

Among other studies that do not overlap with the present study, Keytsman et al., (2024) examined the isometric and isokinetic lower limb strength of elite football players according to their playing positions and found no significant difference in extension and flexion values. The reason for this is that football players are in an active competition period, so it is thought that their strength levels are at a certain level. Another study was conducted by Bonetti et al., (2017) in young football players. According to the results of their study, they found that there was no statistically significant difference between the isokinetic lower limb strength values of defensive players, midfield players, and forward players. It is thought that the reason is due to the fact that the football players completed the preparation phase at the highest level in the pre-season period. Ruas et al., (2015) evaluated the lower limb strength of football players according to their playing positions. According to the results of this evaluation, they reported that there was no difference between the lower limb strength rates of players in other positions except for goal keepers. Based on these results, it can be asserted that there are no differences in the lower limb strength rates of football players in different field positions and therefore in knee strength. AlTaweel et al., (2022) conducted a study to determine the isokinetic strength range of professional football players according to their positions on the field. The results of the current study indicated that there was no statistically significant difference between the isokinetic strength rates of goalkeepers and defensive, midfield, and forward players. In another study conducted in this field, Akyüz et al., (2020) examined the isokinetic strength of elite football players according to their positions. According to the results of the present study, they found no statistically significant difference between the positions in flexion and extension values of 600/s and 3000/s.

The present study has several limitations. The sample consisted of 19 elite male football players. Although the sample size is relatively small, considering the typical squad sizes of professional football teams, it can be argued that the current sample reflects the realities of the sport. Therefore, despite the limited number of participants, the findings provide valuable insights into positional differences among football players. Furthermore, as only male football players were included, the results should not be generalized to female players. Due to the cross-sectional design of the study, the findings reflect the current status rather than causal relationships. Nevertheless, the fact that the measurements were conducted during the pre-season period and under controlled laboratory conditions can be considered a strength that enhances the internal validity of the results.

Conclusion

The present study revealed that there were positive and significant relationships between flexion, extension, and H/Q ratios, indicating that lower extremity strength components complement each other. Although no statistically significant differences were detected between playing positions, it was found that midfielders and forwards demonstrated higher flexion, extension, and H/Q values, whereas defenders exhibited lower values, particularly in H/Q ratios. These differences may hold practical relevance for coaches and performance specialists. In conclusion, despite the positional differences remaining statistically limited, the findings suggest that evaluating lower extremity strength profiles may contribute to the design of preseason training programs that are individualized and position-specific.

Limitations

This study has some limitations that should be acknowledged. The sample was limited to elite-level players, which may influence the generalizability of the findings. Additionally, the cross-sectional design reflects relationships at a single time point. Furthermore, the focus on isokinetic strength provides a specific perspective on performance, while other physical and functional components were not examined.

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