

Isokinetic strength in female soccer players by player position

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This study aimed to establish reference values and compare isokinetic performance in female soccer players according to player position. Eighty-seven female soccer players from the Chilean first-division soccer clubs were evaluated in isokinetic strength. The player position was grouped as goalkeeper (GK), central defender (CD), lateral defender (LD), midfielder (MF), and forward (FW). Concentric knee extension and flexion muscle strength measurements were conducted using a standardized test protocol with an angular velocity of 60°/sec. There were no differences in peak torque of knee extension and flexion between player positions in both the dominant leg (DL) and the nondominant leg (NDL). The H:Q ratio shows significant differences ($p=0.0379$) in the dominant leg between CD vs. MF (GK: 63.1 ± 11.1 ; CD: 55.6 ± 4.6 ; LD: 62.5 ± 9.6 ; MF: 64.8 ± 12.0 ; FW: 61.1 ± 10.9). Our results can be used for practitioners working with female professional soccer players to assess and monitor strength according to player position to improve performance. Future studies should confirm whether these values can be used as risk factors, complementing other functional metrics (e.g., eccentric force) and different angular velocities.

KEYWORDS: isokinetic dynamometer, reference values, torque, balance, football.

INTRODUCTION: Women's soccer has grown exponentially in recent years, and its participation rates are projected to increase to 60 million worldwide by 2026 (Griffin et al., 2021). It is proposed that physical and technical-tactical soccer performance indicators relate to player position. For example, Liu et al. showed that defenders covered more high-intensity and sprint running distances in the high-possession teams, while midfielders and forward covered more high-intensity and sprint running distances in the low-possession teams in male soccer players (Liu et al., 2021). Also, central defenders' overall high-intensity physical match demands are lower than other outfield playing positions in female soccer players (Panduro et al., 2022). High-intensity activities such as jumping, kicking, tackling, turning, sprinting, and changing pace depend on and are improved through muscular strength training (Brígido-Fernández et al., 2022), highlighting the relevance of assessing strength according to player position. Muscle strength is affected by sex and is also sport-specific. Isokinetic dynamometry (IKD) is the gold standard of strength assessment and could be used to objectively quantify the strength of the thigh musculature (Śliwowski et al., 2017). Quadriceps (Q) and hamstrings (H) concentric peak torque could be used as a reference for lower limb biomechanics and athlete's performance (Ardernd et al., 2015; Risberg et al., 2018). H-Q ratio based on concentric peak torque is used as a reference of strength imbalance (Correia et al., 2020), which is essential for determining readiness to return to sport (Eustace et al., 2019; Fousekis et al., 2011). Also, a lower H-Q ratio during concentric action increases the risk of lower-limb injuries (Söderman et al., 2001). It is proposed that the isokinetic peak torque of knee extension and flexion discriminates between player positions in male soccer players (Cosendey et al., 2022;

Salguero et al., 2021). Regarding professional female soccer players, a few studies proposed reference values for overall knee flexion and extension peak torque, differences in H–Q ratio, and between the dominant leg (DL) and the nondominant leg (NDL) (Brígido-Fernández et al., 2022; Risberg et al., 2018). However, studies regarding these values according to the female player position are lacking. Therefore, this study aimed to establish reference values for knee flexion and extension peak torque and to compare these values and related metrics according to player position in female soccer players.

METHODS: All tests were performed in the Laboratory of Exercise Science from Clínica MEDS. All players were free from lower and upper limbs injury for >3 months before data collection. The athletes included in this study were evaluated during the first week after beginning the pre-season training period. Eighty-seven female soccer players (Table 1) from the Chilean first division were evaluated in isokinetic strength. The player position was grouped as goalkeeper (GK), central defender (CD), lateral defender (LD), midfielder (MF), and forward (FW). *Isokinetic strength:* isokinetic concentric knee extension and flexion muscle strength measurements were conducted using a CSMI HUMAC NORM isokinetic dynamometer (CSMi, Stoughton, MA). We used a standardized test protocol and recorded concentric knee extension and flexion torques with an angular velocity of 60°/sec as previously described (Brígido-Fernández et al., 2022). A set of 4 repetitions were conducted with maximal knee extension and flexion effort. The procedure was repeated for the contralateral leg. *Statistical analysis:* Data in the text and figures are presented as means \pm standard deviation (SD). All variables and residuals were considered parametric according to the Kolmogorov-Smirnov normality test. Comparisons of the variables in the isokinetic test were performed using a one-way ANOVA to verify the differences between player position groups. A Bonferroni post hoc test was performed when the analysis of variance found a significant difference. Statistical analysis was performed using STATA 13.0 (StataCorp, College Station, TX, United States). Statistical significance was set at $p < 0.05$.

Table 1: Basic characteristics of soccer players (n=87).

	GK (n=6)	CD (n=17)	LD (n=11)	MF (n=35)	FW (n=18)
Age (years)	26.2 \pm 3.2	23.6 \pm 5.6	21.0 \pm 2.9	23.4 \pm 5.4	24.0 \pm 4.7
Body mass (kg)	66.4 \pm 5.5	60.8 \pm 4.2	58.8 \pm 4.2	59.7 \pm 7.2	59.0 \pm 6.0
Height (cm)	171.9 \pm 4.7	163.0 \pm 5.1	158.6 \pm 4.7	161.0 \pm 5.1	162.4 \pm 4.5
Body mass index (kg/m ²)	22.5 \pm 2.2	22.9 \pm 1.8	23.4 \pm 1.6	23.0 \pm 2.2	22.3 \pm 1.7

RESULTS: *Peak torque values:* Figure 1 shows no differences in absolute quadriceps peak torque in the dominant leg (GK: 176.0 \pm 29.8; CD: 172.4 \pm 20.6; LD: 154.7 \pm 22.4; MF: 157.6 \pm 29.7; FW: 169.8 \pm 24.6; Figure 1A), and in the non-dominant leg (GK: 171.7 \pm 36.0; CD: 167.0 \pm 21.4; LD: 162.5 \pm 22.3; MF: 158.7 \pm 26.0; FW: 172.5 \pm 23.5; Figure 1B) according to player position. Regarding relative quadriceps peak torque, there are no differences in the dominant leg (GK: 2.64 \pm 0.35; CD: 2.83 \pm 0.28; LD: 2.63 \pm 0.35; MF: 2.63 \pm 0.38; FW: 2.87 \pm 0.28; Figure 1C) and in the non-dominant leg (GK: 2.57 \pm 0.47; CD: 2.74 \pm 0.24; LD: 2.76 \pm 0.41; MF: 2.66 \pm 0.32; FW: 2.92 \pm 0.35; Figure 1D) according to player position. Figure 2 shows no differences in absolute hamstring peak torque in the dominant leg (GK: 111.8 \pm 33.3; CD: 95.5 \pm 11.0; LD: 96.7 \pm 20.5; MF: 100.1 \pm 18.6; FW: 103.2 \pm 20.8; Figure 2A), and in the non-dominant leg (GK: 102.5 \pm 26.8; CD: 94.2 \pm 13.3; LD: 102.0 \pm 26.6; MF: 100.3 \pm 19.8; FW: 101.0 \pm 22.5; Figure 2B) according to player position. Concerning relative hamstring peak torque, there are no differences in the dominant leg (GK: 1.68 \pm 0.48; CD: 1.57 \pm 0.14; LD: 1.65 \pm 0.35; MF: 1.68 \pm 0.30; FW: 1.74 \pm 0.29; Figure 2C), and in the non-dominant leg (GK: 1.53 \pm 0.32; CD: 1.54 \pm 0.19; LD: 1.74 \pm 0.50; MF: 1.69 \pm 0.35; FW: 1.70 \pm 0.32; Figure 2D) according to player position. *Asymmetry and H:Q ratio:* Figure 3 shows no differences for quadriceps asymmetry (GK: 6.7 \pm 3.6; CD: 6.4 \pm 4.7; LD: 6.0 \pm 4.7; MF: 7.2 \pm 7.3; FW: 5.8 \pm 3.5; Figure 3A) and hamstring asymmetry (GK: 15.1 \pm 13.6; CD: 9.0 \pm 7.1; LD: 9.5 \pm 11.5; MF: 9.2 \pm 8.1; FW: 7.9 \pm 5.6; Figure 3B) between player position.

Regarding the H:Q ratio, Figure 3 shows significant differences ($p=0.0379$) in the dominant leg between CD vs. MF (GK: 63.1 ± 11.1 ; CD: 55.6 ± 4.6 ; LD: 62.5 ± 9.6 ; MF: 64.8 ± 12.0 ; FW: 61.1 ± 10.9 ; Figure 3C). There are no differences in the non-dominant leg between player positions (GK: 60.4 ± 12.4 ; CD: 56.8 ± 8.5 ; LD: 62.5 ± 11.5 ; MF: 63.8 ± 11.5 ; FW: 58.8 ± 11.3 ; Figure 3D).

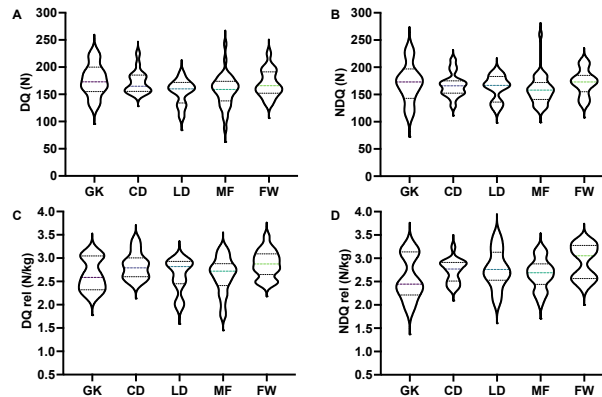


Figure 1. Comparison of isokinetic peak torque during knee extension at $60^\circ/\text{s}$ according to player position.

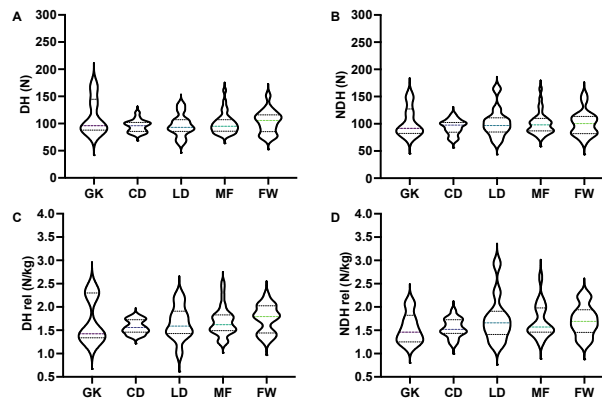


Figure 2. Comparison of isokinetic peak torque during knee flexion at $60^\circ/\text{s}$ according to player position.

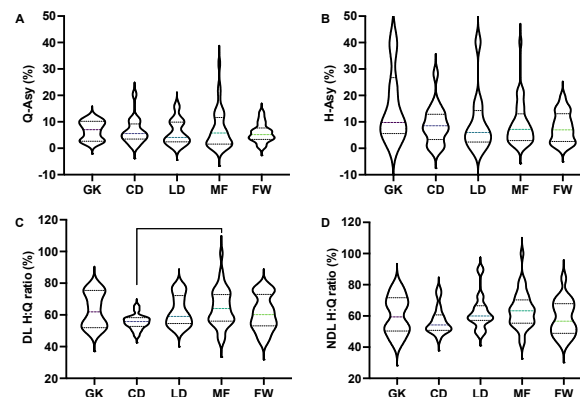


Figure 3. Comparison of asymmetry and H:Q ratio at $60^\circ/\text{s}$ according to player position.

DISCUSSION:

This study aimed to establish knee peak torque and compare related-metrics such as differences in asymmetries and the H:Q ratio between the dominant leg (DL) and the nondominant leg (NDL) in professional female soccer players according to the player position at $60^\circ/\text{s}$. The main finding was that there are no differences in peak torque of knee extension and flexion between player positions in both the dominant leg (DL) and the nondominant leg (NDL). This lack of specificity could be related to a scarcity of development in the Chilean

female soccer league, which has been professional for only one year, making long-term athletic development difficult. However, in our study, female soccer players present higher values in both quadriceps and hamstring absolute strength and H/Q ratio than previously reported (Brígido-Fernández et al., 2022; Risberg et al., 2018). Accordingly, although women's football is progressively shifting to professionalism and the technical level is increasing rapidly, there is still a technical and physical gap between male and female soccer players (Pappalardo et al., 2021). Furthermore, a recent study suggests that professionalization is not necessarily a linear process or beneficial for female English league footballers (Culvin, 2021). On the other hand, it could be related to the specific physical training of the soccer players, where there could be differences in the practice of Strength & Conditioning (S&C) between the coaches of the male and female soccer teams. It has been suggested that fewer weekly S&C sessions in academy players may affect physical development. Also, the increased use of subjective load prescriptions in the academy and first-team women's teams may lead to suboptimal performance gains (McQuilliam et al., 2022). Finally, the angular velocity used (60°/s) is more related to clinical conditions and does not represent the speed manifested during sports activities, highlighting the necessity that future research corroborates possible differences at higher angular velocities according to the playing position. Regarding the H:Q ratio, only CD shows significant differences compared to MF in the dominant leg. A H/Q ratio of 0.6 is frequently used as an injury prevention and rehabilitation tool (Coombs & Garbutt, 2002; Tabor et al., 2021). Accordingly, CD and FW could have more injury risk, especially ACL injuries. However, a recent study proposed that the H:Q ratio has limited value for predicting ACL and hamstring injuries (Kellis et al., 2022). Using more functional metrics, such as the Heccentric/Qconcentric ratio complemented with different angular velocities, could provide references more related to functionality and risk of injury.

CONCLUSION: Our results can be used as a tool for practitioners working with female professional soccer players to assess and monitor strength according to player position to improve performance. Future studies should confirm whether these values can be used as risk factors, complementing other functional metrics (e.g., eccentric force) and different angular velocities.

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