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Lower-Limb Flexibility Profile in 142 Competitive Female Football Players: A Cross-Sectional Study

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Abstract: Background/Objectives: The ROM-SPORT is a test battery for assessing flexibility that measures the range of motion (ROM) in the sport. Restricted or optimal ROM is associated with an increased risk of injury or improved athletic performance, respectively. The aim of the present study was to determine the normative values of the lower limb's flexibility profile by ROM assessment in female football players. Methods: Lower-limb flexibility (11 ROM tests) was measured using the ROM-SPORT battery in 142 female football players (19.42 ± 4.45 years). The tests were performed at the beginning of the training sessions in the first two weeks of the pre-season. Standardized Z-scores (on a scale of 0 to 100 [T-score]) were calculated from the mean and standard deviation to classify the ROM of each movement into three qualitative categories (poor [>−3 to −2], average or normal [−1 to 1; 68.2%], and optimal [1 to >3]) and a traffic light system to facilitate interpretation of the results. Results: The results show normal (or average) ROM values at 32–37° for ankle dorsiflexion with the knee extended; 37–43° for ankle dorsiflexion with the knee flexed; 46–54° for hip internal rotation; 54–61° for hip external rotation; 31–37° for hip adduction; 70–76° for hip abduction with the hip flexed; 41–45° for hip abduction with the hip neutral; 135–141° for hip flexion; 73–82° for hip flexion with the knee extended; 15–21° for hip extension; 121–132° for knee flexion. The normative data presented in this study can be utilized by researchers and practitioners in the women's football league in a variety of ways, provided similar data collection methods are used. Conclusions: Flexibility training is recommended to overcome normal or average ROM and optimize athletic performance with lower injury risk in female football players.

Keywords: soccer; range of motion; stretching; athletic performance; risk factor

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1. Introduction

The ROM-SPORT is a sport-specific testing battery that measures muscle flexibility via range of motion (ROM) [1]. Recent studies have shown that low ROM values in some tests of this battery are important predictors of the risk of sports injury [2–5]. Using machine learning techniques, flexibility measures such as hip flexion with the knee passively extended, hip internal and external rotation, hip abduction, knee flexion, and ankle dorsiflexion with the knee flexed and extended, evaluated through the ROM-SPORT method, have emerged as strong predictors of lower-extremity soft tissue injuries in 260 non-elite male youth football players [3], hamstring strain injury in 96 male professional football

players [2], and other muscular injuries in 98 male professionals [4]. Traditional statistical analysis has also identified decreased hip abduction ROM as a risk factor for groin strains in 306 male players from Iceland's top divisions [6].

In contrast, in women's football, flexibility is often overlooked in injury risk models, largely because many studies do not include ROM assessments in their protocols [7]. To our knowledge, only one recent study has demonstrated that limited hip internal rotation ROM is associated with an increased risk of anterior cruciate ligament (ACL) injuries in 95 competitive female football players, using binary logistic regression and ROC analysis [5]. Some exceptions exist: a few studies have assessed joint hypermobility [8–10] and one has linked excessive ankle ROM to ankle injuries in 300 female players [11]. These findings highlight a significant gap in the literature regarding flexibility as a modifiable risk factor for injury in female football. Given the high incidence of non-contact injuries such as ACL ruptures, hamstring strains, and ankle sprains in this population, injuries that are biomechanically linked to deficits or imbalances in flexibility, further predictive research is urgently needed.

The ROM-SPORT is a battery that has been used extensively to determine the muscular flexibility profile of the lower and upper extremities of male athletes in individual and collective sports [1,12,13]. In the context football, normative values for internal and external rotation of the hip in 90° flexion, internal rotation of the hip in prone position, flexed knee drop, and abduction of the hip in lateral position were determined in 394 asymptomatic male professional football players aged 18–40 years [14], in 68 male professional football players (25.5 ± 5.0 years) from four teams for the hip (flexion with flexed and extended knee, extension, abduction, external and internal rotation), the knee (flexion), and the ankle (dorsiflexion with flexed and extended knee) [13], and in 103 male professional first division footballers and 83 amateur football players for the hip (extension, adduction, abduction, internal rotation and internal rotation). However, only one scientific study was found describing the normal values for hip rotation ROM in 344 individual asymptomatic female football players selected for the Dutch national football teams [15]. In a sense, football professionals and strength and conditioning coaches demand the normative data for flexibility to ensure that women's football players are evaluated on flexibility as well as the other relevant physical abilities that best define the physical demands of competition. This will contribute to enhance decision-making in the design of the flexibility training program.

In general, normative data were reported using descriptive statistics, primarily through mean and standard deviation (SD) values [16]. Some studies also categorized these values into five ranges (very low: ≤ –2 SD; low: –1 to –2 SD; normal: within ±1 SD; high: +1 to +2 SD; very high: ≥+2 SD) [14], while others stratified the results by age group [17]. Additionally, certain authors included a descriptive analysis of lower limb range of motion (ROM), integrating qualitative outcomes based on previously established reference values for athletes at increased risk of injury [13].

Previous researchers [18–20] have recommended using objective reference values derived from statistical measures that indicate how a female football player's ROM compares to normative data from a cohort. Z-scores allow professional football and strength and conditioning coaches to categorize a football female player's ROM test performance relative to her reference cohort (i.e., how many standard deviations above or below the team mean each individual female player is). Consequently, professional football and strength and conditioning coaches can make informed decisions about the design of flexibility training programs based on players whose ROM values are far from the mean (restricted ROM vs. optimal ROM). Z-scores are calculated as a multiple of the standard deviation relative to the mean. Assuming a normal distribution of the data, 99.7% of the individual data points are within three standard deviations of the mean, resulting in a typical Z-score range of −3 to

3, with 0 representing the mean. T-scores would facilitate the interpretation of the Z-score. It is obtained by multiplying the Z-score by 10 and adding 50 [19,20]. This statistical tool would be a great help for female football players, professional football players, and strength and conditioning coaches to qualitatively interpret a player's ROM values in relation to the cohort mean on a scale of 0 to 100 (or 20–80 if a typical cut-off of three standard deviations above the mean is considered) [19,20].

The aim of the present study was to determine the normative values and establish benchmarks for the lower limbs flexibility profile by assessing ROM in female football players. These normal values are documented for hip, knee, and ankle ROM, which can be used as normative data profiles in the clinical assessment, sport screening, and management of female football players.

2. Materials and Methods

2.1. Design

A cross-sectional observational design was used to the normative values and establish benchmarks for the flexibility profile by assessing ROM in female football players. All participants provided informed consent for the study prior to testing, which preapproved by the Institutional Review Board (or Ethics Committee) of the University of Murcia (Reg. Code 2424/2019) for studies involving humans and conformed to the World Medical Association's Declaration of Helsinki. All assessments were carried out in the pre-season (September) of 2021 and 2022. Firstly, information was collected on confounding variables such as demographic data (age, sex, height, weight, and BMI), athletic training data (discipline, years of training in football, training sessions, and training hours per week) and general injuries or medical issue of the female football players. In the second part, the flexibility of the lower limbs (11 ROM tests) was examined using the ROM-SPORT battery in the female football players. Previously, the female football players had a familiarization session of the ROM tests.

2.2. Sample of Female Football Players

A total of 142 female football players of three teams (19.10 $\pm$ 4.49 years, range: 13 to 32 years; 57.78 $\pm$ 7.17 kg; 161.93 $\pm$ 5.30 cm; 22.04 $\pm$ 2.59 kg/m^2) from different leagues in Spain, the Regional League (n = 87), the National League (n = 36), and the First Division League (n = 19), were screened and tested for participation in a single testing session during the 2022 pre-season (September).

During the informed consent process, inclusion and exclusion criteria were reviewed before written informed consent was obtained. Only healthy players ($\geq$13 years old) who were not injured at the time of the assessment were included in the study. Players presenting any current musculoskeletal injury or physical limitation affecting lower-limb function were excluded from participation.

2.3. Procedures

All measurements were conducted in the medical room of the sports facilities under standard conditions (24 °C) and performed by the same two Sports Science experts, each with over 15 years of experience and developers of the ROM-SPORT assessment method [1]. Lower-limb flexibility (11 ROM tests) was analyzed using the ROM-SPORT battery. For a detailed description of the assessment procedure and ROM tests, refer to article [1].

The criterion validity (gold standard) of the ROM tests was based on earlier studies by Gogia et al. [21] and Enwemeka et al. [22] who consider the radiological measurement to be the gold standard, as muscle origin and insertion can be observed and thus muscle extensibility can be determined by ROM. In addition, the ROM tests were selected due to

their operational validity, as recognized by certain American Medical Organizations [23,24], and their inclusion in leading Sports Medicine manuals [17,23], which are grounded in anatomical principles and supported by extensive clinical and athletic experience. Furthermore, previous studies conducted by our research group [1,25] have reported moderate to high intra-tester reliability for all ROM procedures used by the evaluators responsible for the testing sessions. The coefficients of variation (CV) ranged from 0.2% to 9.1%, specifically: 0.4%, 1.7%, 9.1%, 3.5%, 3.7%, 3.5%, 3.4%, 1.0%, 0.2%, and 1.2% for hip flexion with knee flexed and extended, hip extension, hip abduction with hip flexed, hip abduction, hip adduction with hip flexed, hip internal rotation, hip external rotation, knee flexion and ankle dorsiflexion with knee flexed and extended, respectively. Moreover, recent study involving football players has shown no significant differences in reliability metrics for various ROM values and strategy indicators across four separate testing sessions conducted during the first week of preseason [1]. In like manner, previous systematic review has demonstrated that this method of ROM assessment offers more advantages than disadvantages compared to other flexibility assessment protocols [26].

Two weeks prior to the assessment session, testers and participants engaged in practice sessions to promote familiarization with the theoretical foundations and practical execution of the testing protocol. The tests were administered in a randomized circuit format due to time constraints. Maximal passive ROM was determined either by the sensation of a moderate stretch or the identification of a synergistic movement that increased ROM (false negative) [1]. Each test was performed three times per player and the mean of the two closest measurements was used for subsequent statistical analysis.

Before the ROM assessment, a standardized dynamic warm-up of 20 min was carried out, including aerobic exercises and dynamic flexibility drills targeting the whole body [27].

2.4. Statistical Analysis

Data were analyzed with R in Jamovi v.1.6.23 [Computer Software] (https://www.jamovi.org, accessed on 5 January 2025). The ROM metrics were used to compile the normative data and were normally distributed according to the results of a Shapiro–Wilk test.

To justify the union of the data of all the players of competitive levels (or sport categories), a Bayesian ANOVA and Post Hoc Tests were performed for each ROM variable or ROM test (the strength of evidence supporting the alternative hypothesis (H1) was moderate evidence, $BF_{10} \geq 3$ to 10) along with the Error %.

Based on previous research studies [18–20], standardized Z-scores (on a scale from 0 to 100 [T-value]) were calculated from the mean and standard deviation to classify the ROM of each movement into three qualitative categories (poor [>-3 to -2], promising or normal [-1 to 1; 68.2%] and optimal [1 to >3]) and a traffic light system to facilitate the stratification of the results.

To create benchmarks for the presented ROM data, T-score performance bands were created and allocated qualitative descriptions (see the following text in brackets), ranging from excellent to extremely poor, as follows: >80 (excellent), >70–$\leq$80 (very good), >60–$\leq$70 (good), >45–$\leq$55 (average), >40–$\leq$45 (below average), >30–$\leq$40 (poor), $\geq$20–$\leq$ 30 (very poor), and <20 (extremely poor). A traffic light system approach was applied to the T-score performance bands to compliment the allocated qualitative descriptions and thereby further ease data interpretation for the intended end user [28]. The compilation of normative data, construction of T-score performance bands and application of the traffic light system were performed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA).

3. Results

The descriptive analysis reported no significant differences between the three competitive levels, with the exception of age (BF_{10} = 140.93; error % = 0.02), ankle dorsiflexion with the knee flexed (BF_{10} = 80.81; error % = 0.02) and extended (BF_{10} = 58.53; error % = 0.02), hip internal rotation (BF_{10} = 173.80; error % = 0.02), adduction with the hip flexed (BF_{10} = 18.07; error % = 0.01), and hip extension with the knee relaxed (BF_{10} = 246.80; error % = 0.02). Therefore, the descriptive values of all participants in the present study were described (Table 1).

Table 1. Range of motion of the lower limbs in 142 competitive female football players.

Variables	Regional League (n = 87)	National League (n = 36)	First Division League (n = 19)	BF_{10} (Error %)
Age (year)	17.94 ± 4.86	20.47 ± 2.74	21.84 ± 3.55 [1]	140.93 (0.02)
Weight (kg)	57.46 ± 7.41	58.84 ± 7.23	57.24 ± 5.97	0.13 (0.03)
Height (cm)	161.61 ± 5.10	162.76 ± 5.84	161.85 ± 5.24	0.14 (0.03)
BMI (kg/m^2)	22.02 ± 2.83	22.22 ± 2.54	21.80 ± 1.33	0.10 (0.03)
HE (degree)	19.31 ± 6.11	14.92 ± 3.67 [1]	16.42 ± 3.53	246.80 (0.02)
HER (degree)	58.45 ± 8.04	56.94 ± 6.43	55.00 ± 5.81	0.40 (0.03)
HIR (degree)	52.43 ± 7.70	45.89 ± 8.17 [1]	49.00 ± 8.09	173.80 (0.02)
HF_KF (degree)	138.55 ± 6.70	137.50 ± 5.18	136.26 ± 5.91	0.23 (0.03)
HF_KE (degree)	78.08 ± 8.77	79.40 ± 10.51	72.53 ± 7.27 [1,2]	1.53 (0.01)
HAD_HKF (degree)	33.61 ± 5.18	32.31 ± 5.85	37.84 ± 7.74 [1,2]	18.07 (0.01)
HAB_HKF (degree)	73.59 ± 6.15	71.67 ± 6.58	72.89 ± 4.75	0.26 (0.03)
HAB_NHK (degree)	42.43 ± 3.54	43.03 ± 3.74	44.79 ± 4.01	1.15 (0.02)
KF (degree)	128.33 ± 11.40	123.90 ± 9.31	123.50 ± 8.68	1.24 (0.04)
AD_KF (degree)	40.94 ± 5.44	36.90 ± 5.05 [1]	40.79 ± 4.48	58.33 (0.02)
AD_KE (degree)	35.42 ± 4.70	31.99 ± 3.72 [1]	33.89 ± 3.46	80.81 (0.02)

Note: Hip extension with the knee relaxed (HE), hip external rotation (HER) and hip internal rotation (HIR) with the knee flexed, flexion with the knee flexed (HF_KF) and extended (HF_KE), adduction with the hip/knee flexed (HAD_HKF), abduction with the hip/knee flexed (HAB_HKF) and neutral hip/knee (HAB_NHK), knee flexion (KF), and ankle dorsiflexion with the knee flexed (AD_KF), and extended (AD_KE). [1] At least the moderate strength of the evidence in relation to the Regional League; [2] At least the moderate strength of the evidence in relation to the Regional League.

The normative ROM data and benchmarks (based on the T-score bands) for hip extension with the knee relaxed (HE), hip external rotation (HER) and hip internal rotation (HIR) with the knee flexed, hip flexion with the knee flexed (HF_KF) and extended (HF_KE), adduction with the hip flexed (HAD_HF), abduction with the hip flexed (HAB-HF) and neutral hip/knee (HAB), knee flexion (KF), and ankle dorsiflexion with the knee flexed (AD_KF), and extended (AD_KE) ROM tests are shown in Figures 1–11. These benchmarks ranged from extremely poor to excellent, consistent with the T-score performance ranges described previously. These results are reported with the total sample without distinguishing the competitive levels, as the maximum difference between the average values between the sports categories is $\leq 6.54^{\circ}$ and the data are presented in eight categories (from excellent to extremely poor). Therefore, this difference in the values between the sports categories does not show any relevant difference in the traffic light system based on T-score thresholds.

Hip extension		
Level	T-Score	ROM (°)
Excellent	≥80	≥35
Very Good	70 - 80	29 - 35
Good	60 - 70	23 - 29
Above Avg.	55 - 60	21 - 23
Average (Avg.)	45 - 55	15 - 21
Below Avg.	40 - 45	12 - 15
Poor	30 - 40	7 - 12
Very Poor	20 - 30	1 - 7
Extremely Poor	≤20	≤1

Figure 1. Normative data on hip extension with the knee relaxed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip external rotation with the knee flexed		
Level	T-Score	ROM (°)
Excellent	≥80	≥80
Very Good	70 - 80	72 - 80
Good	60 - 70	65 - 72
Above Avg.	55 - 60	61 - 65
Average (Avg.)	45 - 55	54 - 61
Below Avg.	40 - 45	50 - 54
Poor	30 - 40	43 - 50
Very Poor	20 - 30	35 - 43
Extremely Poor	≤20	≤35

Figure 2. Normative data on hip external rotation with the knee flexed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip internal rotation with the knee flexed		
Level	T-Score	ROM (°)
Excellent	≥80	≥75
Very Good	70 - 80	67 - 75
Good	60 - 70	59 - 67
Above Avg.	55 - 60	54 - 59
Average (Avg.)	45 - 55	46 - 54
Below Avg.	40 - 45	42 - 46
Poor	30 - 40	34 - 42
Very Poor	20 - 30	25 - 34
Extremely Poor	≤20	≤25

Figure 3. Normative data on hip internal rotation with the knee flexed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip flexion with the knee flexed

Level	T-Score	ROM (°)
Excellent	≥80	≥157
Very Good	70 - 80	151 - 157
Good	60 - 70	144 - 151
Above Avg.	55 - 60	141 - 144
Average (Avg.)	45 - 55	135 - 141
Below Avg.	40 - 45	132 - 135
Poor	30 - 40	125 - 132
Very Poor	20 - 30	119 - 125
Extremely Poor	≤20	≤119

Figure 4. Normative data on hip flexion with the knee flexed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip flexion with the knee extended

Level	T-Score	ROM (°)
Excellent	≥80	≥105
Very Good	70 - 80	96 - 105
Good	60 - 70	87 - 96
Above Avg.	55 - 60	82 - 87
Average (Avg.)	45 - 55	73 - 82
Below Avg.	40 - 45	68 - 73
Poor	30 - 40	59 - 68
Very Poor	20 - 30	50 - 59
Extremely Poor	≤20	≤50

Figure 5. Normative data on hip flexion with the knee extended ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip adduction with the hip/knee flexed

Level	T-Score	ROM (°)
Excellent	≥80	≥50
Very Good	70 - 80	45 - 50
Good	60 - 70	39 - 45
Above Avg.	55 - 60	37 - 39
Average (Avg.)	45 - 55	31 - 37
Below Avg.	40 - 45	28 - 31
Poor	30 - 40	23 - 28
Very Poor	20 - 30	17 - 23
Extremely Poor	≤20	≤17

Figure 6. Normative data on hip adduction with the hip/knee flexed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip abduction with the hip/knee flexed

Level	T-Score	ROM (°)
Excellent	≥80	≥91
Very Good	70 - 80	85 - 91
Good	60 - 70	79 - 85
Above Avg.	55 - 60	76 - 79
Average (Avg.)	45 - 55	70 - 76
Below Avg.	40 - 45	67 - 70
Poor	30 - 40	61 - 67
Very Poor	20 - 30	55 - 61
Extremely Poor	≤20	≤55

Figure 7. Normative data on hip abduction with the hip/knee flexed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Hip abduction with the neutral hip/knee

Level	T-Score	ROM (°)
Excellent	≥80	≥54
Very Good	70 - 80	50 - 54
Good	60 - 70	47 - 50
Above Avg.	55 - 60	45 - 47
Average (Avg.)	45 - 55	41 - 45
Below Avg.	40 - 45	39 - 41
Poor	30 - 40	36 - 39
Very Poor	20 - 30	32 - 36
Extremely Poor	≤20	≤32

Figure 8. Normative data on hip abduction with the neutral hip/knee ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Knee flexion

Level	T-Score	ROM (°)
Excellent	≥80	≥159
Very Good	70 - 80	148 - 159
Good	60 - 70	137 - 148
Above Avg.	55 - 60	132 - 137
Average (Avg.)	45 - 55	121 - 132
Below Avg.	40 - 45	116 - 121
Poor	30 - 40	105 - 116
Very Poor	20 - 30	95 - 105
Extremely Poor	≤20	≤95

Figure 9. Normative data on knee flexion ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Ankle dorsiflexion with the knee flexed		
Level	T-Score	ROM (°)
Excellent	≥80	≥56
Very Good	70 - 80	51 - 56
Good	60 - 70	45 - 51
Above Avg.	55 - 60	43 - 45
Average (Avg.)	45 - 55	37 - 43
Below Avg.	40 - 45	34 - 37
Poor	30 - 40	29 - 34
Very Poor	20 - 30	23 - 29
Extremely Poor	≤20	≤23

Figure 10. Normative data on ankle dorsiflexion with the knee flexed ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

Ankle dorsi-flexion with the knee extended		
Level	T-Score	ROM (°)
Excellent	≥80	≥48
Very Good	70 - 80	43 - 48
Good	60 - 70	39 - 43
Above Avg.	55 - 60	37 - 39
Average (Avg.)	45 - 55	32 - 37
Below Avg.	40 - 45	30 - 32
Poor	30 - 40	25 - 30
Very Poor	20 - 30	21 - 25
Extremely Poor	≤20	≤21

Figure 11. Normative data on ankle dorsiflexion with the knee extended ROM for 142 female football players with T-score bands and accompanying qualitative descriptions and traffic light system.

4. Discussion

The aim of the present study was to determine the normative values and create benchmarks for the lower limbs flexibility profile by assessing ROM in female football players. Differences have been observed between the three competitive levels in the ankle dorsiflexion with the knee flexed and extended, hip internal rotation, adduction with the hip flexed, and hip extension with the knee relaxed. Generally, ROM has been shown to increase with competitive level. Players competing in the National League have lower ROM (ankle dorsiflexion with the knee flexed and extended, hip internal rotation, adduction with the hip flexed, and hip extension with the knee relaxed) than the Regional League. The cause is longer football practice time (Regional League 5.7 ± 2.9 y vs. National League 8.7 ± 3.2 y), duration of training (Regional League 79.8 ± 31.7 min vs. National League 98.1 ± 15.8 min), and number of training sessions per week (Regional League 3.1 ± 0.5 training vs. National League 4.3 ± 0.9 training) [29,30]. In addition, the load of flexibility training does not increase with higher competition levels and compensates for negative adaptations to football or the increase in age [31,32]. The effects of ageing on flexibility are already apparent at a relatively early age [33].

The results show normal (or average) ROM values at 30–39° for ankle dorsiflexion with the knee extended; 37–43° for ankle dorsiflexion with the knee flexed; 46–54° for hip internal rotation with the knee flexed; 54–61° for hip external rotation with the knee flexed; 31–37° for hip adduction with the hip/knee flexed; 70–76° for hip abduction with the hip/knee flexed; 41–45° for hip abduction with the neutral hip/knee; 135–141° for hip flexion with the knee flexed; 73–82° for hip flexion with the knee extended; 15–21° for hip extension with the knee relaxed; and 121–132° for knee flexion) in the 142 female football players. Other cross-sectional studies report the average values of one or nine lower limb tests in female football players, such as the sit and reach test in 55 female senior football players of First league [34], passive hip flexion and abduction in supine position and passive hip extension, internal and external rotation in prone position and weighted ankle dorsiflexion in 28 adolescent female football players aged 12–19 years from the two highest divisions [35], internal and external rotation ROM in 58 National Collegiate Athletic Association Division I and hip extension, external and internal rotation of the hip, flexion with the knee flexed and extended, abduction with the hip/knee neutral, knee flexion, and ankle dorsiflexion with the knee flexed and extended ROM in 44 professional female football players [36]. However, the evaluation methods, sample size, age, and level of competition are different and do not allow us to compare the results with our scientific study.

The normative data presented in this study can be utilized by researchers and strength and conditioning coaches in the women's football league in several ways, provided that similar data collection methods have been used [12]. Firstly, the data presented can facilitate the interpretation of ROM results achieved by individual competitive female football player. For example, if a female athlete achieves a ROM of 85° for hip flexion with the knee extended, this can be interpreted as an above-average result. Secondly, the data presented can be used to set specific and quantifiable targets for flexibility training for individual female football players. For example, a female football player who achieves a ROM of 70° for hip flexion with the knee extended, which is below average, can be set a ROM target of 73° to reach the lower end of average. Once this value is reached, a new benchmark can be set, e.g., a long-term ROM target of 82° to correspond to the lower ROM value above the average. Thirdly, benchmarks can be set for young women's football players (formative stages) who aspire to a career as First Division League players.

For example, if a female football player achieves 25° in the hip extension range of motion (ROM) test with the knee relaxed, she would be classified at a "Good" level and could potentially improve to "Excellent", thereby enhancing her athletic performance [37–39]. In a sample of 43 young male football players (aged 14 to 18 years), those with greater hamstring flexibility, as measured by the hip flexion with knee extended ROM test, outperformed their peers with lower flexibility in acceleration and sprint tests (5 m, 10 m, and 20 m), the countermovement jump, Balsom agility test, and take-off speed [38]. The hip flexion with the knee extended ROM may be a determining factor for skill performance, as shown by the deficits in kicking in football players with tightness hamstrings compared to athletes with greater hamstring flexibility [39]. Alimoradi et al. [37] have shown that increasing the ROM of the ankle joint through a 4 week soleus stretching programme leads to significant improvements in the Y-balance, drop jump, and Illinois agility tests. On the other hand, if a player reaches a value of 6°, she has a level of "Poor" and increases the risk of a football injury. Tainaka et al. [40], for example, supported this notion by examining hip ROM (flexion, extension, adduction, abduction) in 167 male and female student athletes aged 13–17 years from Japan and reported that lower values of hip internal rotation range of motion [$\leq$35°] and external rotation range of motion [$\leq$46°] were associated with ACL injury. Cejudo et al. [5] found that internal rotation of the hip with a flexed knee ROM of

≤44° and hip extension with the knee relaxed ROM asymmetry of ≥5° were discriminatory for ACL rupture detection in 95 female football players aged 14 to 33 years. Weaver and Relph [41] found that reduced hip flexion and internal rotation on the dominant side of players may increase the risk of lower limb injury in 32 female professional football players (age 23 ± 3.60 years). In contrast, there is a significant relationship between an increased incidence of football injuries and increased joint laxity in 123 senior female football players (elite n = 32 and non-elite n = 91) [42]. Emerging evidence shows that limited ankle dorsiflexion may lead to compensatory landing patterns, such as increased knee valgus and anterior tibial translation, which elevate ACL strain during dynamic tasks [43]. These compensations are particularly concerning in female football players, who already present a higher incidence of ACL injuries. Therefore, addressing joint ROM limitations, especially at the ankle and hip, may be crucial for developing targeted prevention strategies in this population.

On a quantitative level, all the different stretching techniques can improve the extensibility of the muscles and the ROM of the different joints, such as ballistic stretching, dynamic stretching, active statics stretching, proprioceptive neuromuscular facilitation, eccentric flexibility training or passive statics stretching. However, each stretching technique has additional benefits related to the time of application and the procedure of the stretching technique. Ballistic stretching and dynamic stretching are techniques that are recommended during the warm-up. The ballistic stretching training the stretch reflex, which causes contraction of the stretched muscle by the facilitatory influences of muscle spindles type Ia and II receptors upon homonymous alpha motor neuron excitability [44]. The dynamic stretching has a positive effect on ROM and dynamic flexibility, and can increase the spindle reflex afferent excitation of the motor neurons and improve athletic performance (running, jumping, sprinting, and agility) [45]. Active statics stretching improves intermuscular agonist–antagonist coordination [46] and also avoids compensatory movements (maintaining neutral joint stability) during muscle stretching at maximum ROM. Proprioceptive neuromuscular facilitation and Eccentric stretching are techniques that are recommended during the during the main part of a training session or competition. Proprioceptive neuromuscular facilitation, which involves passive static stretches and isometric contractions in a cyclical pattern, is a very effective stretching technique to achieve passive and active ROM and optimize motor performance [47]. Eccentric stretching improves tolerance to eccentric actions and can help prevent muscle–tendon injuries through a full range of motion by training the muscle in a more functional type of activity [48]. Finally, the passive static stretching technique is recommended after of a training session or competition to reduce residual muscle tension (or muscle tone) and muscle stiffness and also to recover muscle tightness caused by exercise [49].

The programs for preventing football injuries [50,51] and improving athletic performance [52–54] recommend a multicomponent intervention that includes a combination of different stretching techniques. It is recommended to apply dynamic stretching and active static stretching before, and passive static stretching after football training or competition; it is also recommended to perform a pure stretching program at home [55]. In general, at least four weeks [56], at least three days per week and six stretching exercises (e.g., iliopsoas, quadriceps, hamstrings, iliotibial band, internal and external rotators of the hip, gastrocnemius/soleus and low back) are recommended [51]. Each exercise is performed in at least 2–3 sets of 15–30 s (10–15 repetitions for dynamic stretching) with a 10 s rest between sets and moderate intensity or discomfort sensation (between four and six RPE points) [53,57,58].

Limitations

When using the normative data presented in this study, several methodological considerations and limitations should be taken into account. First, all data were collected during the pre-season phase, as this was the only period authorized by the coaching staff of the participating women's football teams. Although this ensured that all players were evaluated under comparable performance conditions, it is possible that the recorded ROM values do not represent their maximal in-season capacity. Nevertheless, strength and conditioning coaches generally consider the pre-season to be the most appropriate moment to assess baseline physical capacities [59]. During the competitive phase, variations in training and match schedules across teams introduce heterogeneous training loads that would compromise the comparability required for a multicentric study of this nature [18].

Furthermore, ROM values reported here correspond to the mean of the two most similar measurements obtained across three passive trials, rather than the single highest value. This approach was adopted to enhance the reliability of the data, as averaging reduces measurement error and increases consistency [60,61]. All measurements were conducted after a standardized warm-up to minimize variability associated with viscoelastic changes in soft tissues due to temperature and stretching effects [62].

A further limitation lies in the use of passive ROM testing. While passive techniques are recommended for monitoring flexibility due to their lower intra-individual variability and reduced susceptibility to measurement error, they may not fully reflect dynamic or functional ROM. Active or dynamic ROM tests are influenced by inter-subject variability in muscular strength, neuromuscular coordination (e.g., the balance between agonist activation and antagonist relaxation), and individual motivation levels [26]. Moreover, dynamic tests are prone to compensatory movements, which can produce misleadingly high ROM values (i.e., false negatives) [1]. For a more complete picture, passive assessments should ideally be complemented with kinematic and kinetic analyses of sport-specific movements involving large ranges of motion, in order to identify possible limitations or injury-related compensations.

Finally, future research should explore the relationship between flexibility and other technical and physical parameters of the upper limbs and trunk, assessing their potential contribution to performance enhancement and injury prevention.

5. Conclusions

In conclusion, we recommend incorporating targeted flexibility training to help female football players exceed average ROM values and thereby optimize performance while reducing injury risk. Our proposed approach to compiling and presenting normative data and objective benchmarks offers a practical reference for practitioners; however, it should be interpreted with caution. These findings are not directly generalisable to other populations (e.g., male athletes or athletes from different sports) or to studies using different methodological criteria (e.g., control of compensatory movements, end-of-range definitions, or alternative measurement tools).

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