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REVIEW ARTICLE

How can we assess neuromuscular performance in female football players? A systematic review

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ABSTRACT

Women's football has experienced exponential growth in popularity, leading to a notable improvement in player performance and an increased interest in optimizing player development. This systematic review aimed to identify the most frequently used tests for evaluating neuromuscular performance in female football players. In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, we conducted a systematic search of the literature using keywords related to football, neuromuscular training, and measurement methods. The literature search yielded 109 articles (PubMed = 27; WoS = 31; Scopus = 32; SportDiscus = 19). After screening, 19 articles met the inclusion criteria and were thoroughly reviewed. The most commonly assessed variables in neuromuscular testing included jump ability, agility, sprinting, fitness, strength, and balance. The wide variety of tests used for each skill, coupled with a lack of standardized methodologies, hinders the establishment of robust recommendations. Consequently, further research is necessary to evaluate the validity of these tests and to develop an appropriate battery of neuromuscular assessments.

Keywords: Women, Soccer, Strength, Performance analysis.

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INTRODUCTION

Football is among the world's most popular and widely played sports. In recent years, women's football has experienced significant growth in participation, visibility, and competitive level. Along with its increasing popularity, its physical and physiological demands have also risen. Elite-level female footballers now often exceed 33 matches per season, facing higher match loads and reduced recovery periods (FIFPRO, 2023). During competition, players typically cover approximately 10 km per match, with around 28% of this distance classified as high-speed running (≥18 km/h) (Beato et al., 2023). In this context, the implementation and enhancement of specific measures (i.e: optimizing neuromuscular training, establishing force thresholds) is clearly needed. The importance of strength as a performance optimizer has been demonstrated (Lauersen et al., 2018), as it improves coordination, load tolerance, and neurocognitive function while lower-limb strength also plays a fundamental role in neuromuscular performance, as it directly influences key capacities such as agility, sprinting speed, and explosive movements (Hammami et al., 2018).

However, the physical intensification of the game also raises injury risks. Anterior cruciate ligament (ACL) injuries occur 3 to 6 times more frequently in female than in male players, and approximately one-third of affected athletes experience reinjury (Montalvo et al., 2018; Webster et al., 2021). Multicomponent exercise-based programs—including strength, core, and balance training—have shown to reduce overall injury incidence by 27% and ACL injuries by 45% (Crossley et al., 2020). Moreover, not only multicomponent preventive programs may help reduce injury rates, but showing greater levels of fitness and strength has also been shown to improve athletes' tolerance to training loads. In fact, Malone et al. (2019) demonstrated that athletes with superior neuromuscular qualities—specifically greater lower-body strength, sprinting speed, and RSA—are significantly more resilient to high workloads and acute spikes in training load. In contrast, those with lower neuromuscular profiles had up to four times greater injury risk.

All together, these findings reinforce the need to assess neuromuscular performance through a comprehensive battery of tests rather than relying on isolated or generalized measures. Despite this, female football players are still frequently evaluated using protocols developed for male cohorts, often failing to capture the unique neuromuscular differences compared to men and the differents demands of the women's game. This highlights a critical gap in the literature and supports the need for a systematic review that identifies and synthesizes the most relevant assessment tools for this population. Therefore the aim of this study is to synthesize the existing literature on neuromuscular performance in female football players and offer evidence-based recommendations for practitioners, ultimately highlighting the importance of tailored training approaches in optimizing performance and reducing injury risks.

MATERIALS AND METHODS

This systematic review focuses on identifying the tests used to evaluate neuromuscular performance in female football players. The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009) and adhered to the minimum criteria established by the Cochrane Back Review Group. Additionally, the review was registered with the International Prospective Register of Systematic Reviews (PROSPERO, ID: CRD42024621019).

Literature search strategy

Literature search was conducted in four databases: PubMed, Web of Science (Wos), SCOPUS and SportDiscus. Literature search was conducted during October and November 2024. The search strategy for each database was: ("*football*" OR "*football*") AND "*performance*" AND ("*test*" OR "*evaluation*") AND ("*female*"

OR "*women*") AND "*neuromuscular*". The eligibility criteria were defined according to the following PICOS criteria:

- Population: Female football (soccer) players of any age or competitive level.
- Intervention: tests used to measure neuromuscular performance in female football (i.e: jumping tests, strength tests, sprint tests).
- Comparison: between the different tests.
- Outcomes: Quantitative assessment of neuromuscular performance using field-based or laboratory-based tests.
- Study design: controlled intervention studies and observational cohort and cross-sectional studies.

Studies were included if: (1) the participants were female or male and female, with the results presented separated by sex; (2) the intervention involved one or more measurements of physical abilities o neuromuscular factors.

Studies were excluded if: (1) studies with neuromuscular test with other objectives (e.g., risk of injury, mental factors); (2) studies with other sports (e.g., volleyball, basketball); (3) Studies that included male-only samples or mixed samples without sex-specific data; (4) reviews, abstract/papers conference, surveys, opinion pieces, commentaries, books, periodicals, editorials, case studies, non-peer-reviewed text, or Master's and/or doctoral thesis. Returned titles and abstracts were downloaded into an excel sheet (Microsoft Corporation, Redmond, WA, USA) and screened for elegibility criteria. After remove cross-references and duplicates data were extracted by one researcher. In case of conflict a second researcher resolved differences by consensus. The general characteristics and findings were summarized in Table 1.

Table 1. General characteristics of studies reviewed.

Author	Objective	Population	Study design
Roso-Moliner et al. (2023)	To evaluate the effects of a neuromuscular training program on physical performance and asymmetries in female football players	38 female football players of Second Spanish Division	Randomized controlled trial
Armada-Cortés et al. (2022)	To analyse the influence of the neuromuscular fatigue produced by an RSA test in elite female soccer players on the physical performance and hamstring extensibility	24 female football players of Second Spanish Division. (20-23 years)	Cross-sectional study
Armada-Cortés et al. (2022)	To analyse the influence of hamstring injury history on the neuromuscular fatigue produced by an RSA test	19 female football players of Second Spanish Division. (20-23 years)	Cross-sectional study
Lindblom et al. (2012)	To evaluate the effect of the Swedish neuromuscular warm-up programme on different performance tests	73 female football players (12-16 years).	Randomized controlled trial
López-Valenciano et al. (2018)	To analyse the relationship between several parameters of neuromuscular performance with unilateral dynamic balance	44 female professional football players. (16-24 years)	Cross-sectional study
Armada-Cortés et al. (2020)	To compare the validity of the take-off velocity method measured with a force platform vs flight time method in a vertical jump	8 female soccer players. (21-33 years)	Randomized controlled trial
Thorpe et al. (2008)	To examine the influence of limb preference and strength on SEBT performance in a group of NCAA Division I athletes	11 recreationally active females and 12 female (19-21 years) football players of NCAA Division I (18-20 years)	Randomized controlled trial
Smith et al. (2018)	To describe and provide the initial data for the LEGS methodology	19 female football players (11-20 years)	Cross-sectional study

Belamjahad et al. (2024)	To contrast the effects of neuromuscular training versus endurance training in preseason program on measures of physical fitness and injuries	24 female professional football players (16-18 years)	Randomized controlled trial
Noyes et al. (2013)	To determine if the training program could improve neuromuscular and athletic performance	124 school female soccer players (12-18 years)	Randomized controlled trial
Sonesson et al. (2020)	To evaluate the correlation between performance and neuromuscular control tests	49 female soccer players (13-16 years)	Correlational study
McLean et al. (2012)	To examine how Pmax changes in relation to training and match load through a season	16 female football players NCAA Division I (17-20 years)	Cross-sectional study
Wallmann et al. (2008)	To examine the effects of three different stretching techniques (static, contract-relax stretching and no stretch)	12 female Division I collegiate soccer players (18-25 years)	Repeated measures design
Kobal et al. (2023)	To describe changes in power and aerobic performance after a training program	18 female elite soccer players (23-32 years)	Single group repeated measures design
Isla et al. (2021)	To assess the effectiveness of a 12-week neuromuscular warm-up program on performance in strength, jumping and dynamic balance	41 female soccer players of Spanish First Division academy (13-14 years)	Randomized controlled trial (single blinded)
Paravlic et al. (2024)	To study the associations between bilateral and unilateral power/force in relation to tests derived from TMG	35 female soccer players from first division of Slovenia (15-25 years)	Cross-sectional study
La Torre et al. (2007)	To evaluate explosive force in 7 vs 7 and 11 vs 11 in female soccer players and changes during season	13 female soccer players of 11-on-11 soccer (22 years) 26 female soccer players of 7-on-7 soccer (23 years)	Cross sectional study
Prieske et al. (2018)	To examine the acute effects of combined balance and strength vs strength exercise on twitch contractile properties of plantar flexor muscles, jump performance and maximum voluntary strength	12 elite female soccer players (14-15 years)	Randomized cross-over design
Wen et al. (2024)	To compare the effectiveness of small-sided games and HIIT programs in adaptations in aerobic capacity, COD and jumping performance	48 recreative female soccer players (16-18 years)	Randomized controlled trial

Quality assessment

In the case of cross-sectional studies, the "*Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies*" proposed by the National Hearts, Lung and Blood Institute (NIH National Heart, Lung, and Blood Institute, website) was used. This scale is based on the use of 14 items: was the research question or objective in this paper clearly stated? (Nº1), was the study population clearly specified and defined? (Nº2), was the participation rate of eligible persons at least 50% (Nº3), were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants? (Nº4), was a sample size justification, power description, or variance and effect estimates provided? (Nº5), for the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured? (Nº6), was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed? (Nº7), for exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)? (Nº8), were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? (Nº9), was the exposure(s) assessed more than once over time? (Nº10), were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? (Nº11), were the outcome assessors blinded to the exposure status of participants? (Nº12), was loss to follow-up after baseline 20% or less?

(Nº13), were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)? (Nº14).

In the case of experimental studies, we adopted a modified quality-assessment screening scoring system (Pardos-Mainer et al., 2024). Which one evaluated the following items: inclusion criteria clearly defined (Nº1), subjects were randomly allocated to groups (Nº2), intervention was clearly defined (Nº3), groups were tested for similarity at baseline (Nº4), a control group was used (Nº5), outcome variables were clearly defined (Nº6), assessments were practically useful (Nº7), duration of intervention was practically useful (Nº8) between-group statistical analysis was appropriate (Nº9), point measures of variability (Nº10).

Table 2. Quality assessment tool for experimental studies.

Studies	Item										Score
	1	2	3	4	5	6	7	8	9	10	
Roso-Moliner et al. (2023)	Y	Y	Y	Y	Y	y	Y	Y	Y	y	10
Lindblom et al. (2012)	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	9
Armada-Cortés et al. (2022)	Y	N	Y	-	N	Y	Y	N	-	Y	5
Armada-Cortés et al. (2022)	Y	N	Y	-	N	Y	Y	N	-	Y	5
Belamjahad (2024)	Y	N	Y	Y	N	Y	Y	N	Y	Y	7
Noyes et al. (2013)	Y	-	Y	Y	N	N	N	Y	Y	Y	6
Wen et al (2024)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10
Isla et al. (2021)	Y	N	Y	Y	N	Y	Y	Y	Y	Y	9
Kobal et al. 2023	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Prieske et al., (2018)	N	Y	Y	Y	Y	Y	Y	N	Y	Y	8

Note. Y = yes; N = no; - = not knowing.

Table 3. Quality assessment tool for observational cohort and cross-sectional studies.

Studies	Item														Score
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
McLean et al. (2012)	Y	Y	Y	Y	Y	Y	Y	NR	Y	Y	Y	N	Y	NR	11
Armada-Cortés et al. (2020)	Y	Y	Y	Y	N	Y	N	NA	Y	N	Y	NR	Y	NR	8
La Torre et al. (2007)	Y	N	Y	Y	N	Y	Y	NR	Y	Y	Y	NR	Y	NR	8
Paravlic et al. (2024)	Y	Y	Y	N	N	Y	Y	NR	Y	Y	Y	N	Y	NR	8
Sonesson et al. (2020)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	NR	11
López-Valenciano et al. (2018)	Y	Y	Y	N	Y	Y	Y	NR	Y	Y	N	Y	Y	NR	10
Wallmann et al. (2008)	Y	Y	Y	Y	Y	Y	Y	CD	Y	Y	Y	CD	Y	NR	11
Smith et al. (2018)	Y	Y	Y	Y	Y	N	Y	NA	Y	Y	Y	N	Y	NA /NR	10
Thorpe et al. (2008)	Y	Y	Y	Y	N	N	N	NR	Y	N	Y	N	Y	NR	7

Note. Y = yes; N = No; NA/NR = not applicable/not responding.

Analysing cross-sectional studies, we found certain criteria that we were not able to confirm in the interventions (confounding variables and their possible adjustment). Highest score obtained was 11/14, which is in line with other interventions using this scale (Pardos-Mainer et al., 2024). This shortfall is frequently attributable to the absence of information regarding potential confounding factors and the variability in exposure levels among the variables assessed.

Data extraction

Two authors examined the articles, title and abstract in the first stage of screening. If any disagreements occurred a second author examined the situation and discussed together. Then, demographic details were extracted: sample size, age and level of playing.

Methodological descriptions were organized according to the type of test employed and the instrumentation used (e.g., force platform, photocells). Subsequently, the results were analysed to determine whether significant differences were present or if the test was valid for assessing neuromuscular performance. A summary of the various methodologies and their corresponding results is presented in Table 4.

Table 4. Methodologies and results of the studies.

Studies	Test
Roso-Moliner et al., (2023)	Horizontal jump test Countermovement jump test Ankle dorsiflexion range of motion 40m speed test 505 COD
Thorpe et al. (2008)	Isokinetic strength testing Star excursion balance test
Armada-Cortés et al. (2022)	Hamstring Test Countermovement jump test RSA
Armada-Cortés et al., (2022)	Hamstring test Countermovement jump test RSA
Lindblom et al. (2012)	Star excursion balance test Modified Illinois agility test Countermovement jump test Triple-hop for distance test
López-Valenciano et al. (2018)	Y-balance test Isometric hip abduction and adduction strength Lower extremity joint range of motion Core stability Isokinetic knee flexion and extension strength
Armada-Cortés et al., (2020)	Countermovement jump Squat jump
Smith et al. (2018)	Y-Balance Test Drop Vertical Jump Test (jump biomechanics) Triple crossover hop for distance test (lower limb power)
Belamjahad et al., (2024)	Countermovement jump (Muscle power) Squat jump (Muscle power) 1-RM (Maximal strength) 30-m sprint T-Test (Change of direction speed) Repeated shuttle sprint ability Yo-Yo Intermittent Recovery Test (YYIRLT1) Loughborough soccer passing test (LSPT)
Noyes et al. (2013)	Video Drop-Jump Test Vertical Jump Tests T-test 37-m sprint test Multistage fitness test
Sonesson et al., (2020)	Drop Vertical Jump (DVJ) T-test Single leg hop for distance test 505 COD Side hop test 10m and 20m sprint Tuck jump assessment (TJA) Countermovement jump (CMJ)
McLean et al. (2012)	Maximal Power Output
Wallmann et al., (2008)	T-test

Isla et al., (2021)	Back squat and hip thrust Countermovement jump test Y-balance modified test
Paravlic et al., (2024)	Tensiomiography assessment (TMG) Countermovement jump (bilateral and unilateral) and squat jump 30m sprint Soccer-specific change of direction test (SSCOD) Isokinetic strength testing
La Torre et al., (2007)	Countermovement jump and squat jump
Prieske et al., (2018)	Twitch contractile properties Maximum voluntary strength Countermovement jump Drop jump
Wen et al., (2024)	Countermovement jump 505 COD Test 30-15
Kobal et al. (2022)	Squat jump CMJ Yo-Yo Intermittent Recovery Test 1

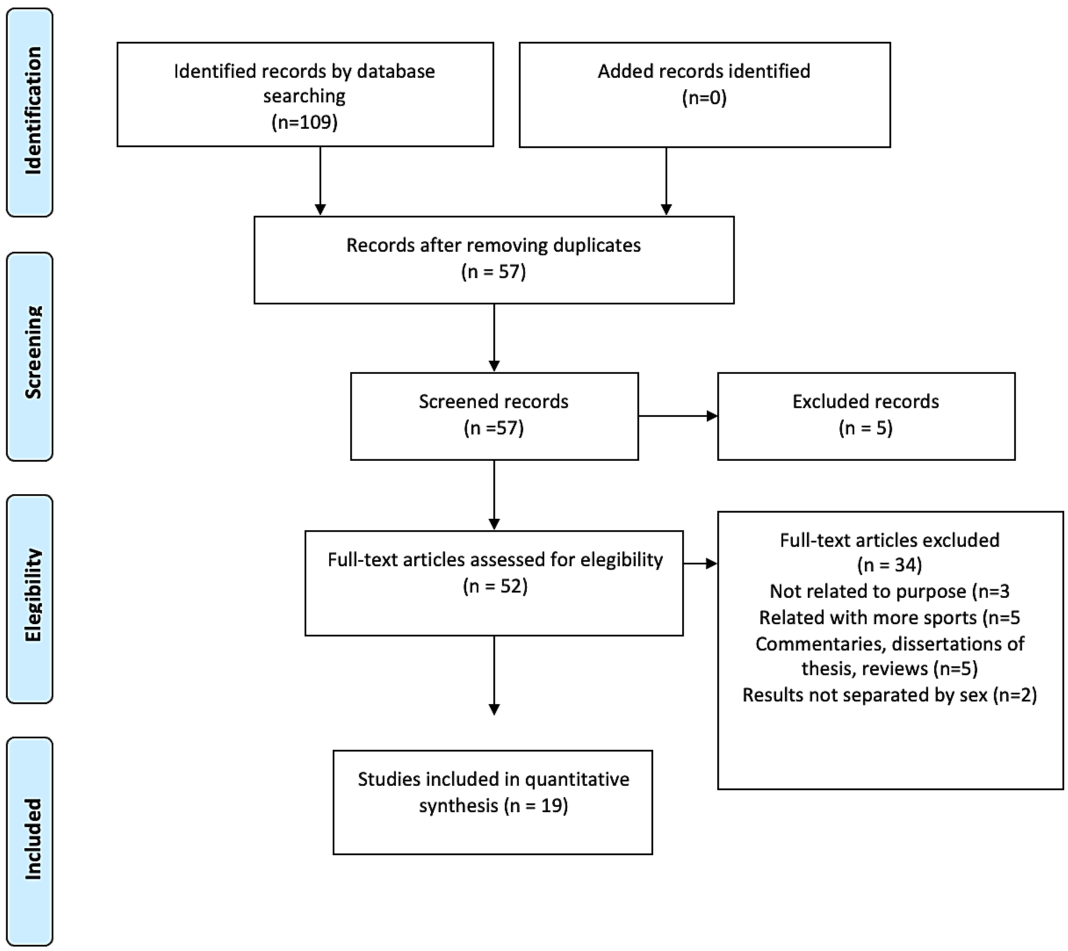

Figure 1. Flow diagram.

RESULTS

The initial search retrieved a total of 473 articles. After removing 78 duplicates, 395 titles and abstracts were screened. Of these, 68 articles were selected for full-text review, and finally, 36 studies met the inclusion criteria and were included in the analysis. The selection process is illustrated in Figure 1 following PRISMA 2020 guidelines.

Search results

Figure 1 presents the flow diagram outlining the study selection process.

Jump performance assessments

The Countermovement Jump (CMJ) is the most frequently employed test for evaluating lower-limb strength and power. Its primary purposes include monitoring the positive effects of strength and endurance training while providing valuable insights into athletes' fatigue levels through jump height analysis. The CMJ is employed for both bilateral and unilateral lower-limb strength assessments. Squat Jump (SJ) is predominantly used to measure lower-limb power. Drop Jump (DJ) is incorporated to evaluate contact time and determine the reactive strength index (RSI) of subjects. Triple Hop for Distance test has been used to evaluate lower-limb asymmetries, whereas the Horizontal Jump Test has been included in certain interventions to assess functional imbalances, as well as bilateral and unilateral power. Triple Crossover Hop for Distance test forms part of a comprehensive battery for assessing neuromuscular function of the lower extremities, providing valuable data on potential asymmetries and injury risk.

Neuromuscular performance tests

10-Repetition Maximum (10-RM) method estimates maximal strength using a submaximal load (10 repetitions) and conversion tables. This method has been applied to the back squat and bench press. Isokinetic strength testing, conducted via dynamometry, evaluates peak torque during abduction, adduction, extension, and flexion movements, allowing for the calculation of hamstring-to-quadriceps ratios across different angular velocities. Core stability has been assessed using force plates, with measurements conducted in seated positions on both stable and unstable surfaces, providing real-time feedback on centre-of-pressure displacement. Accelerometers have been employed to analyse mean velocity during back squat and hip thrust exercises. Contractile properties and maximal voluntary strength have been evaluated using electrical muscle stimulation and dynamometry. In this context, tensiomyography has been used to assess muscle deformation in response to electrical stimulation, offering insights into knee extensor and flexor muscle function.

Agility assessments

Agility tests involve rapid changes in direction, high-speed movements, and turns. Modified Illinois Agility Test evaluates agility and change of direction (COD) capacity. 505 Test specifically assesses acceleration and COD capacity, while the T-Test measures multidirectional agility through a T-shaped movement pattern.

Football-specific tests

Football-specific change of direction tests are utilized to assess players' ability to execute rapid movements, demonstrating high reliability and validity. The Loughborough Football Passing Test measures execution time, while the Loughborough Soccer Passing Test (LSPT) evaluates soccer-specific technical performance.

Sprint assessments

Sprint tests, including 30m, 20m, and 37m sprints, have been employed to assess athletes' capacity to perform high-intensity efforts. The measurement of split times at 5m and 10m is essential for analysing acceleration capacity.

Aerobic fitness assessments

The Yo-Yo Intermittent Recovery Test Level 1, the Multistage Fitness Test, and the 30-15 Intermittent Fitness Test have been used to evaluate the aerobic capacity of football players. These assessments allow for the estimation of maximal oxygen uptake (VO2max) and provide data on maximal heart rate.

Balance assessments

The Star Excursion Balance Test (SEBT) is a widely used measure of dynamic balance, possessing predictive value for injury risk and demonstrating significant differences across performance levels (Plisky et al., 2009). The Y-Balance Test (YBT) enables coaches to assess neuromuscular control, strength, and flexibility.

These assessments provide a comprehensive evaluation of physical performance in athletes, offering valuable information for training optimization, injury prevention, and performance enhancement.

We can see a resume of the tests used in Figure 2.

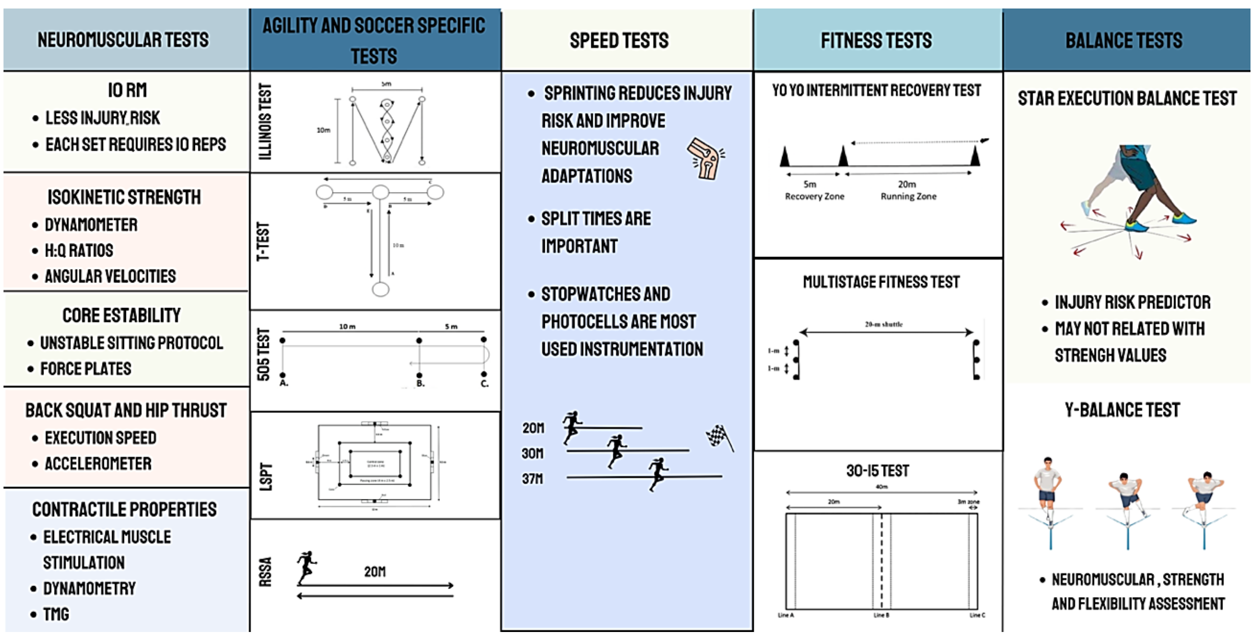

Figure 2. Compilation of the neuromuscular tests of the studies reviewed.

DISCUSSION

This systematic review aimed to identify and synthesize the neuromuscular performance tests most commonly used in female football players. The findings reveal a clear lack of standardization in assessment protocols and highlight the broad variability in the neuromuscular qualities evaluated across studies. Most assessments focused on jumping and sprinting ability, while other key components such as strength, balance, and change of direction were less frequently addressed or measured inconsistently.

24 measurements related to jumping ability were identified. The most frequent approach involves contact platforms using the flight-time method (Linthorne et al., 2001), a valid technique for vertical jump assessment, though data cannot be directly compared across different measurement instruments. Force platforms, considered the gold standard (Lake et al., 2018), provide highly accurate data but are costly, while video-analysis apps offer a low-cost alternative with confirmed validity (Vieira et al., 2023), although their precision is lower.

Less common tests, such as drop jumps and triple crossover hops, have also been used. Including the drop jump as a neuromuscular assessment tool is key, as it provides insights into the reactive strength index and tendon stiffness (Bishop et al., 2019). Hop tests may be associated with lower-limb power (Hamilton et al., 2008), however, further research is required to confirm this relationship.

There is a lack of standardization in jump execution, trial numbers, and rest intervals, with methodologies varying considerably. This aligns with previous findings indicating the absence of standardized procedures (Petrigna et al., 2019). Establishing technical parameters is essential to enhance comparability across studies.

There is a relationship between aerobic fitness and the ability of the players to sustain prolonged, high intensity efforts during matches (Parpa et al., 2024). Although it is not an indicator of neuromuscular performance, it can be a good test at any time during the season (Bok et al., 2021).

T-test has specific football gestures provides greater ecological validity (i.e.: 180º turns, changes in running direction), while 505 test and Illinois test lack of these features. In this line, Loughborough football passing test (LSPT) is used to see how fast can players complete all the passes making the fewest mistakes. Repeated shuttle sprint ability test (RSSA) assesses the performance when doing intermittent efforts through changes of direction, it may allow coaches to study difference between categories (Impellizzeri et al., 20008). We propose the use of a more analytic test (i.e.: T-test, 505 test) with another one which includes more specific playing movements or actions with the ball (i.e.: LSPT, SSCOD).

There is a relationship between performance in 10-m and 30-m sprint and playing level (Haugen et al., 2013). Measurement of split times (i.e.: 5m and 10m) is key to analyse acceleration capacity.

Recent evidence suggests that maximal power and velocity are strongly correlated with performance variables (Marcote-Pequeño et al., 2019). In line with other interventions, one of the studies reviewed (Plyski et al., 2009), shows there is evidence that squat jump and countermovement jump unloaded correlate with sprint performance (Manson et al., 2021). Thus, using sprint test would provide us many key factors of performance.

Research suggests that longer sprints (e.g., 40 m) yield higher peak speeds, which may be beneficial for assessing maximum sprint capacity (Beato et al., 2023). Conversely, shorter sprints (e.g., 5 m) exhibit greater variability and lower reliability.

Isokinetic variables have been shown to correlate with tensiomyographic measurements (Paravlic et al., 2024), providing valuable insights for injury prevention. Although isokinetic testing is considered the gold standard for strength assessment (Paul et al., 2015), its outcomes can vary significantly across different age groups (Menzel et al., 2013).

The assessment of contractile properties is both a valid and reliable method for detecting muscular asymmetries in the lower limbs (Rodriguez-Ruiz et al., 2012). These contractile properties could be associated with strength-related parameters, such as the capacity to generate maximal voluntary contractions (Prieske et al., 2018).

Estimation of one-repetition maximum (1-RM) provides relevant information regarding the relationship between sprint performance and jump height (Pedersen et al., 2021 However, the high injury risk associated with the 1RM test leads coaches to employ alternative methods. such as the 10-RM test (Taga et al., 2024).

Velocity-based training (VBT) offers a practical approach for estimating 1-RM values while also monitoring fatigue levels in athletes (Janicijevic et al., 2024). Despite the growing interest in strength assessment, there is a significant lack of research on strength levels in female football players. The absence of a standardized methodology and the variability in instrumentation and testing procedures makes it difficult to establish normative values or performance benchmarks. We propose that incorporating at least one strength and power assessment test should be considered essential.

No significant relationship is reported between performance in balance tests and neuromuscular performance. However, including a balance test can contribute to performance assessment and injury prevention, particularly in young female athletes.

Study limitations and practical applications

Numerous limitations must be acknowledged regarding the practical application of this review. A wide variety of tests are employed to assess different neuromuscular capacities, each of which may be conducted using diverse methods and instruments. However, standardised methodologies ensuring greater reliability are lacking, with factors such as the number of valid attempts, rest intervals, and procedural variations contributing to inconsistency. For instance, we identified studies utilising single measurements, others involving short intervention periods (e.g., one week), and some implementing training programmes lasting several months or entire seasons. Additionally, there is significant variability in sample sizes across studies, ranging from as few as eight participants to as many as 120, which can influence the reliability and interpretation of the data obtained. These factors highlight the necessity of contextualising both individual studies and their results.

This review aims to assist coaches and strength and conditioning practitioners by identifying the most commonly employed tests for evaluating neuromuscular capacities in female football players. In many cases, the data derived from assessment tests may not accurately reflect real-world performance. The absence of representative and reliable data can lead to erroneous conclusions; therefore, results should be interpreted with caution and, where possible, on an individual basis.

CONCLUSIONS

Neuromuscular performance in female football players is typically assessed using tests designed to measure muscle power and lower limb strength. The countermovement jump (CMJ) and squat are among the most widely utilised assessments, while sprint performance is often evaluated over distances of 10 and 30 metres to measure speed.

Agility is frequently assessed using the T-test due to its simplicity; however, incorporating football-specific movements could improve the ecological validity of such evaluations. Balance assessments, such as the Y

Balance Test (YBT), are commonly used to identify asymmetries associated with injury risk, although their correlation with other performance metrics remains limited.

Strength evaluation is increasingly emphasised with the use of advanced tools, including force platforms, electromyography, one-repetition maximum (1RM) testing, and dynamometry, which provide detailed and accurate insights into strength capacities. Aerobic capacity, on the other hand, is often assessed using cost-effective field-based tests.

Despite recent advancements, research on neuromuscular assessment in female football players remains limited. This lack of evidence makes it challenging to establish reference values across different age groups and competition levels. Current findings underline the necessity for a multidimensional approach to testing, incorporating various complementary assessments to achieve a comprehensive evaluation of performance.

AUTHOR CONTRIBUTIONS

Claudia Moreno-Ortega was responsible for the overall writing of the manuscript and the screening of the articles. Jaime González-García conducted the quality analysis of the selected studies and contributed to the research design. Blanca Romero-Moraleda participated in the screening process and performed a comprehensive review of the entire manuscript.

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No potential conflict of interest was reported by the authors.

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