Physical performance in young female football athletes: a systematic review[1]

Desempenho físico em jovens atletas de futebol feminino: uma revisão sistemática

Rendimiento físico en jóvenes deportistas de fútbol: una revisión sistemática

[Systematic review]

Yuri Rolim Lopes Silva[2]
Rodrigo Gomes de Souza Vale[3]
Giullio César Pereira Salustiano Mallen da Silva[4]
Andressa Oliveira Barros dos Santos[5]
Juliana Brandão Pinto de Castro[6]
Ignácio Antônio Seixas da Silva[7]
Vicente Pinheiro Lima[8]
Rodolfo de Alkmim Moreira Nunes[9]

Received: July 20, 2023
Accepted: October 09, 2023

Cite as:
Lopes Silva, Y. R., Gomes de Souza Vale, R., Pereira Salustiano Mallen da Silva, G. C., Oliveira Barros dos Santos, A., Brandão Pinto de Castro, J., Seixas da Silva, I. A., Pinheiro Lima, V., & de Alkmim Moreira Nunes, R. (2024). Desempenho físico em jovens atletas de futebol feminino: uma revisão sistemática. *Cuerpo, Cultura Y Movimiento*, *14*(1). https://doi.org/10.15332/2422474X.9861

---

[1] Systematic review article. No financing. Laboratory of Exercise and Sport (LABEES). Rio de Janeiro State University (UERJ). Rio de Janeiro. Brazil.
[2]Master's student in the Postgraduate Program in Exercise and Sports Sciences (PPGCEE), UERJ, Rio de Janeiro, Brazil. Email: professoryurirolim@gmail.com; ORCID: https://orcid.org/0000-0002-5973-3773
[3]Professor in the Postgraduate Program in Exercise and Sport Sciences (PPGCEE) and Coordinator Laboratory of Exercise and Sport (LABEES), Rio de Janeiro State University (UERJ), Rio de Janeiro, Brazil. Email: rodrigogsvale@gmail.com; ORCID: https://orcid.org/0000-0002-3049-8773
[4]PhD candidate in the Postgraduate Program in Exercise and Sports Sciences (PPGCEE), UERJ, Rio de Janeiro, Brazil. Email: giulliocesar.gc@hotmail.com; ORCID: https://orcid.org/0000-0001-8701-8550
[5]PhD candidate in the Postgraduate Program in Exercise and Sports Sciences (PPGCEE), UERJ, Rio de Janeiro, Brazil. Email: professoroliveira.andressa@gmail.com; ORCID: https://orcid.org/0000-0002-7412-7229
[6]PhD in the Postgraduate Program in Exercise and Sports Sciences (PPGCEE), UERJ, Rio de Janeiro, Brazil. Email: julianabrandaoflp@hotmail.com; ORCID: https://orcid.org/0000-0002-5656-0782
[7]Adjunct Professor at Estácio de Sá University, Cabo Frio, Rio de Janeiro, Brazil. Email: ignacioseixas@gmail.com; ORCID: https://orcid.org/0000-0002-8151-3910
[8] Professor in the Postgraduate Program in Exercise and Sports Sciences (PPGCEE) and Coordinator of the Research Group on Biodynamics of Performance, Exercise and Health (BIODESA), UERJ, Rio de Janeiro, Brazil. Email: professorvicentelima@gmail.com; ORCID: https://orcid.org/0000-0002-7534-265X
[9]Professor in the Postgraduate Program in Exercise and Sport Sciences (PPGCEE) and Coordinator Laboratory of Exercise and Sport (LABEES), Rio de Janeiro State University (UERJ), Rio de Janeiro, Brazil. Email: rodolfoalkmim@gmail.com; ORCID: https://orcid.org/0000-0001-9707-2649

Abstract

The objective was to analyze the physical performance in female soccer players. A systematic review was performed by searching MedLine (PubMed), SPORTDiscus, Web of Science, ScienceDirect, Scopus, Lilacs (BVS) and SciELO databases for observational studies performed on female soccer players under 18 years of age, who underwent neuromuscular and/or cardiorespiratory physical testing. Of the 934 studies found, 19 were included. The sample size in the studies ranged from 11 to 499 players, with total of 1879 athletes, aged between 9 and 17 years. Neuromuscular tests were more used than cardiorespiratory ones. In conclusion, jumps, linear velocity and change of direction were more used in the context of soccer played by women to determine performance in young athletes. However, cardiorespiratory capacity tests were used to a lesser extent, with a predominance of the level 1 yo-yo intermittent recovery test (YYIR1).

Keywords: female athlete, physical assessment, young, athletic performance

Resumen

El objetivo fue analizar el rendimiento físico en jugadoras de fútbol. Se realizó una revisión sistemática buscando en las bases de datos MedLine (PubMed), SPORTDiscus, Web of Science, ScienceDirect, Scopus, Lilacs (BVS) y SciELO. estudios observacionales realizados en jugadoras de fútbol menores de 18 años que se sometieron a neuromusculares y/o pruebas físicas cardiorrespiratorias., se incluyeron 19 estudios. El tamaño de la muestra en los estudios osciló entre 11 y 499 jugadores, con un total de 1879 atletas, con edades entre 9 y 17 años. Las pruebas neuromusculares fueron más utilizadas que las cardiorrespiratorias. En conclusión, los saltos, la velocidad lineal y el cambio de dirección fueron más utilizados en el contexto del fútbol jugado por mujeres para determinar el rendimiento en deportistas jóvenes. Sin embargo, las pruebas de capacidad cardiorrespiratoria se utilizaron en menor medida, con predominio del test de recuperación intermitente yo-yo de nivel 1 (YYIR1).

Palabras clave: mujer atleta, evaluación física, joven, desempeño atlético

Introduction

Football practiced by women has gained many fans in recent years, with practitioners all over the world. It is estimated that around 13.4 million athletes are registered, representing a considerable increase, mainly among young people, in the last 5 years. About 25% of these registered athletes are young female soccer players under 18 years of age (FIFA, 2019). As a result of the increase in practitioners, there are also greater demands in training and higher levels of performance in competitions (Čović et al., 2016)

Soccer is an intermittent sport, in which the athlete performs high-intensity activities interspersed with moments of low-intensity activities in different periods of the game (Bradley et al., 2010; Bangsbo et al., 2006; Krustrup et al., 2010). During matches, high-level female soccer players cover, on average, a total distance of 10 km. However, of this distance covered, about 10% are performed at high intensity, represented by activities at speeds above 16 km/h (Datson et al., 2014).

High-intensity activities, such as sprints, jumps, and ball-driving speed, have increased during games (Bush et al., 2015; Junior et al., 2021). Sprint activities are determinant among the game patterns in elite players who perform more high-speed runs and cover greater distances during the game when compared to lower-level players (Gualtieri et al., 2023). Activities like these are decisive in games, such as offensive and defensive actions, ball disputes, and goal moments (Modric et al., 2019; Sasaki et al., 2015), as they are actions that require great demand for muscle power, such as running, jumping, attacking, and changing direction. These factors can determine who wins a football match (Park et al., 2019). Furthermore, soccer players rely mainly on aerobic metabolism to sustain their work rate during a 90-minute match (Garcia-Tabar et al., 2019). Such actions demand that the players demonstrate a high level of physical abilities, that is, speed, power, strength, and aerobic capacity, requiring that the athletes have good athletic development (Modric et al., 2020).

The physical abilities of the players are decisive for success in a soccer match. However, this is a complex sport, in which several factors can affect competition success and final performance (Smith et al., 2018). Therefore, understanding the performance characteristics of female soccer players can help in the preparation of training planning. To assess these physical abilities, a wide variety of physical tests are used, which can be performed in the laboratory or in a field environment, which is more used by coaches and physical trainers (Emmonds et al., 2023).

Some literature reviews were carried out with soccer players related to physical performance (Slimani & Nikolaidis, 2017; Altmann et al., 2019; Sarmento et al., 2018; Pardos-Mainer et al, 2021; Pardos-Mainer et al., 2020). Of these, only two reviews were specifically with the female audience (Pardos-Mainer et al, 2021b; Pardos-Mainer et al., 2020). However, only one review specifically studied young athletes in the process of sports training (Pardos-Mainer et al., 2020).

Furthermore, with the rise of women's football in recent years, resulting from the proposal of the Fédération Internationale de Football Association (FIFA), Confederación Sudamericana de Fútbol (CONMEBOL) and Confederação Brasileira de Futebol (CBF), to expand football played by women. which includes young athletes. Therefore, evaluating the physical capacity of athletes is necessary to identify performance deficits and seek to improve them. Therefore, this systematic review aimed to analyze the characteristics of physical performance in young female football players.

Methods

Delimitation

The present study is a systematic review that followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021) recommendations and registered in the International Prospective Register of Systematic Reviews (PROSPERO), under number CRD42022338800.

Eligibility

For the eligibility of studies, the acronym PICOS was adopted, in which they were included observational studies carried out with young female soccer players under the age of 18, who underwent physical tests of a neuromuscular and/or cardiorespiratory nature, were included. Review articles, articles published in congresses, master's dissertations, doctoral theses, and articles in the submission phase were excluded.

Search Routine

The search strategy was conducted with the keywords *physical performance*, *physical fitness*, *athletic performance, female soccer*, and *female football*, using Boolean operators “AND” between terms and “OR” between synonyms. The search phrase was structured as follows: ("physical performance"[Title/Abstract] OR "physical fitness"[Title/Abstract] OR "athletic performance"[Title/Abstract]) AND ("female soccer"[Title/Abstract] OR "female football"[Title/ Abstract]). Based on this search routine, searches were carried out in the following databases: MedLine (via PubMed), SPORTDiscus, Web of Science, ScienceDirect, Scopus, Lilacs (via VHL), and SciELO, in December 2022 without any search filter by time.

After searches, all references were exported to an online EndNote library shared between three researchers who excluded duplicates. From there, two experienced researchers independently read the title and abstract to assess whether it would be included in reading the full text. In case of any divergence, a third researcher was consulted. In the next step, all articles included based on the inclusion criteria were read in full.

Methodological Quality

Methodological quality was assessed using the Critical Appraisal Skills Program (CASP) (CASP, 2018) tool, available at: http://www.casp-uk.net/casp-tools-checklists. The CASP tool contains 12 questions to be answered with “yes”, “no”, or “can't tell”. Between 10 and 12 “yes” answers were considered as high quality, seven to nine as moderate quality, and zero to six as low quality, as recommended by Smith et al. (2016). With the intention of having greater rigor in the evaluation, the tool was created to consider possible biases that may be contained in a scientific article in the context of the research. Thus, two researchers integrated with the subject of the study carried out the evaluation that could affect the quality of the articles. A third researcher was requested when there was divergence during the evaluation.

Data extraction

To analyze the studies, the following data were extracted: authors, year of publication, country, number of participants, age, competitive level, period of the data collection season, and maturation. In addition to these, data related to physical tests, assessment instruments, familiarization, and results were analyzed.

Results

In total, 934 studies were found following the search methodology (PubMed = 76; SPORTDiscus = 72; Web of Science = 193; ScienceDirect = 81; Scopus = 254, VHL = 240; SciELO = 18). After applying the eligibility criteria, 19 studies were included in this systematic review (Figure 1).

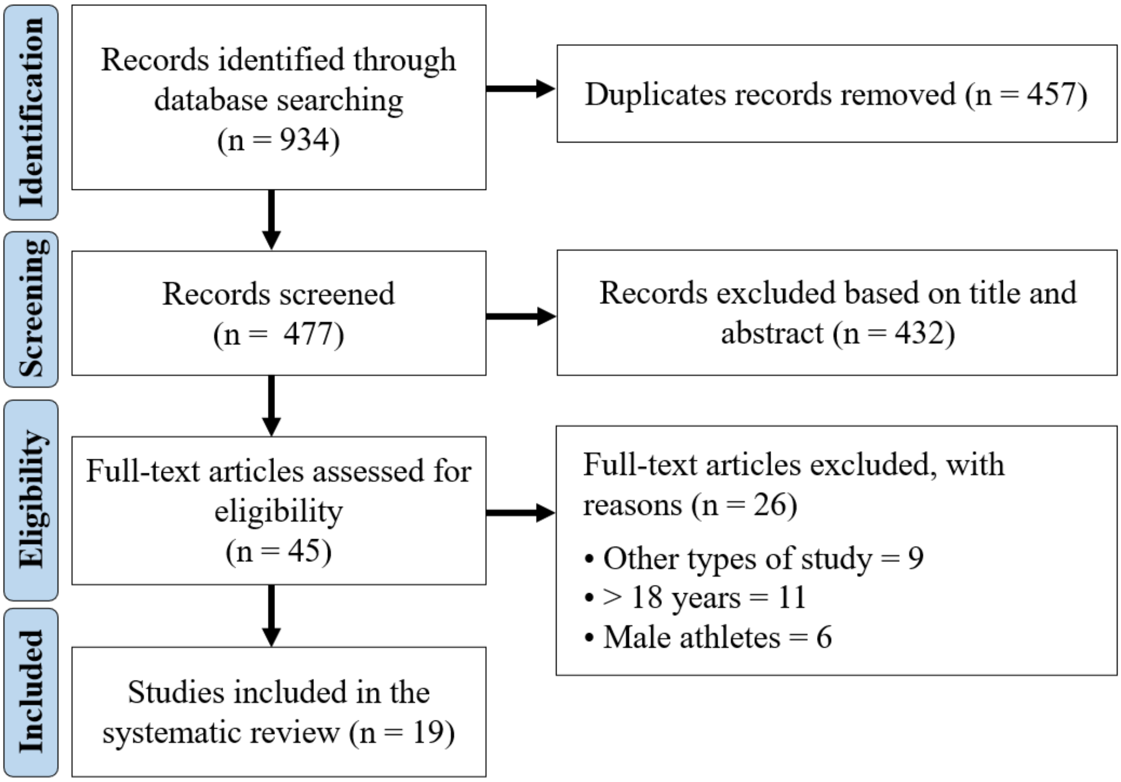

Figure 1. PRISMA flowchart of the study selection procedure.

Table 1 shows the descriptive characteristics of the studies included in this review. The studies were developed in 13 different countries, showing heterogeneity in the countries where research on the subject is carried out. The country with the most studies included was the United Kingdom, with 4 studies. When stratified by continent, Europe stood out with 12 studies. The year of publication of the studies ranged from 2011 to 2021. Most studies (n = 14; 74%) were performed between 2018 and 2021. Of these, three were from 2021(Bishop et al., 2021; Pardos-Mainer et al., 2021b; Ramos et al., 2021), which can demonstrate an increase in searches with football played by women in recent years. The sample size in the studies ranged from 11 to 499 players aged between 9 and 17 years with different competitive levels, in which 9 studies were divided into categories by age (Emmonds et al., 2020; Emmonds et al., 2018; Jeras et al., 2020; O'Brien-Smith et al., 2020; Pardos-Mainer et al., 2021a; Póvoas et al., 2016; Ramos et al., 2021; Romero-Caballero et al., 2021; Vescovi et al., 2011) in the table 1.

Table 1. Characteristics of the selected studies.

Authors	**Year**	**Country**	**Sample** (n)	**Age** (years)	**Competitive level**	**Period of the season**	**Maturation**

Adigüzel et al.	2020	Turkey	11	15.9 ± 0.3	National and international	NI	No
Bishop et al.	2021	UK	19	10 ± 1.1	Elite	NI	No
Datson et al.	2020	UK	282	12.7–15.3	Elite	NI	Yes
Emmonds et al.	2018	UK	U10: 30 U12: 38 U14: 43 U16: 46	U10: 9.25 ± 0.58 U12: 11.41 ± 0.98 U14:13.22 ± 0.65 U16: 15.05 ± 0.64	NI	Start of season	No
Emmonds et al.	2020	UK	U10: 30 U12: 38 U14: 43 U16: 46	U10: 9.25 ± 0.58 U12: 11.41 ± 0.98 U14: 13.22 ± 0.65 U16: 15.05 ± 0.64	NI	Start of season	Yes
Haag et al.	2016	Germany	NBP: 8 BP: 10	NBP: 15.8 ± 0.71 BP: 15.9 ± 0.99	1st, 2nd, 3rd national league division	NI	No
Hammami et al.	2020	Tunisia	24	16.5 ± 0.4	National	End of season	Yes
Höner et al.	2019	Germany	499	11.4 ± 0.3	NI	NI	No
Jeras et al.	2020	Netherlands	U12: 20 U15: 24 U17: 16	U12: 10.6 ± 0.6 U15: 13.1± 0.8 U17: 16.8 ± 1.3	National and international	Mid-season	No
Jeremic et al.	2019	Serbia	II: 2 DD: 14 ID: 11 RR: 7 XX: 5 RX: 15	14–18	National team	Pre-season	No
Lyle et al.	2015	USA	14	16.1 ± 0.8	High school	NI	No
Manson et al.	2014	New Zealand	18	16–18	Elite	End of season	No
Merino-Muñoz et al.	2021	Chile	17	16.4 ± 0.75	National	Pre-season	No
O’Brien-Smith et al.	2020	Australia	FSAG: 21 FSG: 36 FIG: 20	FSAG: 11.1 ± 0.6 FSG: 13.3 ± 0.8 FIG: 16.2 ± 0.9	National	Start of season	Yes
Pardos-Mainer et al.	2021a	Spain	U18: 18 U16: 21 U14: 15	U18: 16.9 ± 0.5 U16: 14.9 ± 0.5 U14: 13.7 ± 0.6	National	NI	No
Póvoas et al.	2016	Portugal	U12: 24 U14: 20 U16: 21	U12: 9.7 ± 0.7 U14: 12.5 ± 0.9 U16: 14.8 ± 0.8	Regional	NI	No
Ramos et al.	2021	Brazil	U15: 46 U17: 49	U15: 14.7 ± 0.5 U17: 16.5 ± 0.5	National	Start of season	No

Romero-Caballero et al.	2021	Spain	U19: 17	U19: 15.43 ± 1.32	National, regional, and local	2nd month of the season	No
Vescovi et al.	2011	USA	U13: 78 U16: 223	U13: 12.6 ± 0.5 U16: 15.3 ± 1.0	National and regional	Start of season	No

BP: back pain group; DD: homozygote power; FIG: female investment group; FSAG: female sampling group; FSG: female specialization group; ID: heterozygote; II: homozygote resistance; NBP: no back pain group; NI: not informed; RR: power gene; RX: mixed gene; UK: United Kingdom; USA: United States of America; XX: resistance gene; U: under.

Table 2. presents data on the instruments used, familiarization with the tests, tests used, and results of each selected study.

Table 2. Data extraction from the studies.

Studies	**Instruments**	**FAM**	**Test: attempts**	**Results**
Adigüzel et al. (2020)	NI	NI	SEBT: 3	SG > VG in posterolateral and lateral (right leg) SG > VG in medial and posterior (left leg)
Bishop et al. (2021)	My Jump; Electronic timing gates	Yes	SLCMJ: 3 SLH: 3 SLHT: 3 SLHC: 3 S5, S10, S20m: 3	Asymmetry (p<0.05) entre SLCMJ (right) > SLCMJ (left) (p>0.05). Greater asymmetries were associated with longer sprint reading times (p>0.05). SLCMJ asymmetry was associated with reduced vertical jump performance. Asymmetries in SLHT were associated with shorter horizontal jump distances (p>0.05).
Datson et al. (2020)	Contact platform; Electronic timing gates	Yes	CMJ: 3 S20m: 3 YYIR1: 1	50 evaluated were selected for U17 and U20. YYIR1 was the best test to predict those selected for U17 and U20.
Emmonds et al. (2018)	Force platform; Electronic timing gates; OptoJump	Yes	IMTP: 2 CMJ: 3 505COD: 3 S10 e S30m: 3 YYIR1:1	PF: U16 > U14 > U12 > U10 CMJ: U16 > U14 > U12 > U10 505COD: U16 > U14 > U12 > U10 YYIR1: U16 > U14 > U12
Emmonds et al. (2020)	Force platform; Electronic timing gates; OptoJump	Yes	IMTP: 2 CMJ: 3 505COD: 3 S10 e S30m: 3 YYIR1: 1	Higher maturational age categories performed better in PF, RFP, CMJ, 505COD
Haag et al. (2016)	Isokinetic dynamometer	Yes	YBT: 3 MIMST: 2 SOT: 1	NBP > BP in SOT dynamic lateral flexion in plank position for the right and left
Hammami at al. (2020)	Electronic timing gates; OptoJump	Yes	CMJ, SJ: 3 S5, S10, S30m: 3 TT: 2 YYIRI1: 1	CMJ, SJ, S5, S10, S30m < International standards data. TT and YIRI1 = International standards data.
Höner et al. (2019)	Electronic timing gates	Yes	S20m: 2 ATW e ATB: 2 BCT: 2 AT: 1	For all NT > RA > NS tests, except for the AT test, where NT > RA = NS

Jeras et al. (2020)	Force platform; Linear transducer	Yes	CMJ: 2 SJ: 2 DJ: 2	For the 3 groups height of CMJ > SJ > DJ U17 > U12 e U15 height CMJ, SJ, and DJ U17 > U15 > U12 PP from CMJ; U3 > U2 e U12 PP from SJ U17 < U15 < U12 CT and RSI from DJ
Jeremic et al. (2019)	Electronic timing gates	Yes	S5, S20m: 3 Zig-zag: 3 SJ: 3 CMJc: 1 YYIRI1: 1	DD and ID > RR, XX, RX, and II on the S5m RR and RX > DD, ID, XX and II in CMJc
Lyle et al. (2015)	Force platform; isokinetic dynamometer; Vertec	Yes	LED: 2 MIMST: 2 CMJ: 3 CAT: 6	Strong association between LED and unilateral and bilateral CAT ($p<0.05$) MSG > WSG in CMJ and one-sided CAT
Manson et al. (2014)	Isokinetic dynamometer; motorized treadmill	No	MIMST: 2 SKK: 1 SLH: 3 SLL: 3 IFT: 1	U17 < U20 and Adult group for CHE, CHF, EKF U17 < U20 and Adult group for RPTHE U17 < U20 and Adult group for CT, FT, SF, SL Adult group > U20 and U17 for SLH and SLL Adult group > U17 and U20 for VIFT and VO_{2max}
Merino-Muñoz et al. (2021)	Contact platform; Electronic timing gates	No	CMJ: 2 S10, S30m: 2 COD180º: 4	Young group < Adult group in CMJ, COD180°, and CODD
O'Brien-Smith et al. (2020)	Swift Performance; Smart Speed Timing Gate System	No	DM: 2 CMJ: 2 S5, S30m: 2 TT: 2 YYIRI1: 2	FSG > FSAG and FIG for TT and YIRI1 FIG > FSG and FSAG for CMJ, S5m and S30m
Pardos-Mainer et al. (2021a)	OptoJump; Electronic timing gates	Yes	SLCMJ: 3 SLHT: 3 S10,20,30 e S40m: 3 COD180º: 3	U18 > U14 for SLCMJ and COD180º with left leg U16 > U14 for S40m and COD180º
Póvoas et al. (2016)	NI	No	YYIRI1: 1 YYIE1: 1 YYIE2: 1	U12, U14 and U16 (all trained) > U12, U14, U16 (all untrained in soccer) for YYIR1, YYIE1, YYIE2
Ramos et al. (2021)	Contact platform; Electronic timing gates	Yes	CMJ, SJ: 3 S20m: 3 YYIRI1: 1	U15 = U17 for CMJ, SJ, S20m, and YIRI1
Romero-Caballero et al. (2021)	My Jump2	No	CMJ: 3 LEGER:1	CMJ: 20.65 ± 5.05 cm Leger test: 4.76 ± 1.75 MLEGER: 10.38 ± 0.87 km/h VO_{2max}: 39.87 ± 5.01 LO_2/min
Vescovi et al. (2011)	Electronic timing gates; Contact platform	No	CMJ: 3 S9.1, S18.3, S27.4, S36.6m: 3 IAT: 3 PAT: 3	U13 < U16 for CMJ, S9.1; S18.3; S27.4; S36.6; IAT and PAT

AT: agility test; ATB: agility test with ball; ATW: agility test without ball; BCT: ball control test; BP: back pain group; CAT: cross-agility test; CHE: concentric hip extension; CHF: concentric hip flexion; CMJ: countermovement jump; CMJc: seven continuous jumps; 505COD: left/right, change of direction test; COD180º: modified version of the 505COD; CODD: deficit in the COD180º; CT: contact time; DD:

homozygote power; DJ: drop jump; DM: decision-making; EKF: eccentric knee flexion; FAM: familiarization; FIG: female investment group; FSAG: female sampling group; FSG: female specialization group; FT: flight time; IAT: Illinois agility test; ID: heterozygote; IFT: intermittent fitness test; II: homozygote resistance; IMTP: isometric midthigh pull; LED: LED test; LEGER: incremental run test; MIMST: maximum isometric muscle strength test; MLEGER: maximum speed in Leger; MSG: men's football group; NBP: no back pain group; NI: not informed; NS: not selected; NT: youth national team; PAT: Pro-agility test; PF: peak force; PP: peak power; RA: regional association team; RFP: relative force peak; RPTHE: relative peak torque hip extension; RR: power gene; RSI: reactive strength index; RX: mixed gene; SEBT: Star Excursion Balance Test; SF: step frequency; SG: soccer group; SJ: squat jump; SKK: sprint kinetics and kinematics; SL: step length; SLCMJ: single leg countermovement jump; SLH: single leg horizontal jump; SLHC: single leg triple hop test crusader; SLHT: single leg triple hop test; SLL: single leg lateral jump; S5m: speed 5 meters; S10m: speed 10 meters; S20m: speed 20 meters; S30m: speed 30 meters; S40m: speed 40 meters; S9,1m: speed 9,1 meters; S18,3m: speed 18,3 meters; S27,4m: speed 27,4 meters; S36,6m: speed 36,6 meters; SOT: Swiss Olympic Test; TT: T-test change of direction; Vertec: heel height measuring device; VIFT: Velocity in the intermittent fitness test; VG: volleyball group; VO_{2max}: maximum oxygen uptake; U: under; XX: resistance gene; YBT: Y Balance Test; YYIE1: Yo-Yo intermittent endurance level 1; YYIE2: Yo-Yo intermittent endurance level 2; YYIR1: Yo-Yo intermittent recovery test level 1; WSG: women's soccer group; Zig-zag: Zig-zag agility test.

Table 3 shows the result of the methodological quality analysis carried out with the CASP tool. All studies showed high methodological quality, as scores were equal to or greater than 11.

Table 3. Methodological quality of the selected studies (CASP).

Study	1	2	3	4	5a	5b	6a	6b	7	8	9	10	11	12	Score
Adigüzel et al. (2020)	S	S	S	S	S	S	S	S	S	NI	S	S	S	S	11
Bishop et al. (2021)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
Datson et al. (2020)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
Emmonds et al. (2018)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Emmonds et al. (2020)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
Haag et al. (2016)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Hammami et al. (2020)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Höner et al. (2019)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
Jeras et al. (2020)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Jeremic et al. (2019)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Lyle et al. (2015)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Manson et al. (2014)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
Merino-Muñoz et al. (2021)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
O'Brien-Smith et al. (2020)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Pardos-Mainer et al. (2021a)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12
Póvoas et al. (2016)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12

Ramos et al. (2021)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Romero-Caballero et al. (2021)	S	S	S	S	S	S	S	S	S	N	S	S	S	S	11
Vescovi et al. (2011)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	12

1 = The study addressed a clearly focused question; **2** = The cohort was recruited in an acceptable manner; **3** = Exposure was accurately measured to minimize bias; **4** = The result was accurately measured to minimize bias; **5a =** Authors identified all important information, confounders; **5b =** They took confounders into account in the design and/or analysis; **6a=** Follow-up of subjects was complete enough; **6b =** Follow-up of subjects was sufficient; **7** = What are the results of this study; **8** = How accurate are the results; **9** = You believe in the results; **10** = Results can be applied to the local population; **11** = The results of this study are adequate with other evidence (discussion); **12** = What are the implications of this study for practice. S = yes; N = no; NI = not informed.

Discussion and Implication

This review aimed to analyze the characteristics of physical performance in young female soccer players. Of the 19 included studies, 9 (64%) aimed to compare performance on physical fitness tests in different categories. In 7 of these studies, better performance was demonstrated in older age categories, regardless of the assessed physical capacity (Emmonds et al., 2020; Emmonds et al., 2018; Jeras et al.,2020; O'Brien-Smith et al., 2020; Pardos-Mainer et al., 2021a; Romero-Caballero et al., 2021; Vescovi et al., 2011). However, only the study by Emmonds et al. (2020). divided the categories by maturational age. O'Brien-Smith et al. (2020) evaluated the maturational age, but the division of age groups by chronological age was consistent with the maturational age of the groups.

Four studies (Manson et al., 2014; Merino-Muñoz et al., 2021; Ramos et al., 2021; Romero-Caballero et al., 2021) compared the performance of young athletes with adults. The studies by Manson et al. (2014), Merino-Muñoz et al. (2021), and Ramos et al. (2021) obtained statistically superior results in adult athletes compared to young athletes in different types of tests. However, Romero-Caballero et al. (2021) did not observe performance differences between adult and young athletes. The authors reported that these results may have occurred due to the competitive level of the athletes, who were regional and local (Romero-Caballero et al., 2021).

The studies by Romero-Caballero et al. (2021), O'Brien-Smith et al. (2020), and Lyle et al. (2015) also compared performance between boys and girls. In the study by Romero-Caballero et al. (2021), male athletes from the U16 and U19 categories obtained better results than the female U19 category in the countermovement jump (CMJ) and maximum oxygen uptake (VO_{2max}). In turn, in the study by O'Brien-Smith et al. (2020), girls performed better in the sampling categories (9–11 years old) than boys for the yo-yo intermittent recovery test level 1 (YYIR1). However, in the specialization (12–14 years old) and investment (15–17 years old) phases, boys achieved better results in the speed, jump, and YYIR1 tests. Lyle et al. (2015) identified greater performance for boys in agility tests when compared to girls.

Two studies (Datson et al., 2020; Höner et al., 2019) aimed to identify the physical fitness test as a predictor of talent selection. In the study by Datson et al. (2020), the YYIR1 was the main test to determine the probability of international success in young female soccer players and Höner et al. (2019) observed that the athletes designated for the U17 selection presented better performances in speed and agility in comparison with athletes from the regional association, who, in turn, obtained better performances than the non-selected ones.

Three (Bishop et al., 2021; Lyle et al., 2015; Pardos-Mainer et al., 2021a) of the selected studies were dedicated to investigating the relationships between physical performance tests. Bishop et al. (2021) analyzed the correlation between the asymmetry in the performance of the vertical and horizontal jump with the linear sprint, in which the result shows a correlation between greater asymmetries and lower performance in the sprint. Additionally, it was found that greater asymmetries correlated with lower performances in CMJ and horizontal jump (Bishop et al., 2021). The study by Lyle et al. (2015) identified a strong negative correlation between the unilateral and bilateral agility test and the unilateral lower limb strength test. Pardos-Mainer et al. (2021a) investigated the relationship between asymmetry in jumps and the change of direction test and observed that there was no correlation between these variables.

Four studies (Adigüzel et al., 2020; Haag et al., 2016; Jeremic et al., 2019; Póvoas et al., 2016) compared different groups of athletes. Haag et al. (2016) compared athletes with and without low back pain in an isometric and dynamic strength test and balance test, noting differences only in the dynamic strength test of lateral trunk flexion. Jeremic et al. (2019) divided the athletes into groups of genes. One group with a predominance of strength and power and the other group with resistance predominance. The strength and power predominance group performed better in the vertical jump and the initial 5m sprint. However, the study by Adigüzel et al. (2020) compared the performance of soccer and volleyball players in the Star Excursion Balance Test (SEBT), resulting in smaller ranges for female soccer players. Póvoas et al. (2016) analyzed the performance of female soccer players and non-athletes of different age groups in three variations of the yoyo test. In all age groups, girls trained in soccer performed better.

The players' performance was analyzed in different types of physical tests, with a greater variety related to neuromuscular performance. To assess power, the vertical jump was used in 15 studies. Of these studies, CMJ was performed in 11 (Datson et al., 2020; Emmonds et al., 2018; Emmonds et al., 2020; Hammami et al., 2020; Jeras et al., 2020; Lyle et al., 2015; Merino-Muñoz et al., 2021; O'Brien-Smith et al., 2020; Ramos et al., 2021; Romero-Caballero et al., 2021; Vescovi et al., 2011), in which 5 studies demonstrated better performance in older age categories (Emmonds et al., 2018; Jeras et al., 2020; O'Brien-Smith et al., 2020; Romero-Caballero et al., 2021; Vescovi et al., 2011). Only in the study by Ramos et al. (2021) no difference was observed in CMJ performance between categories U15 and U17. Unilateral vertical jump was performed in 2 studies (Bishop et al., 2021; Pardos-Mainer et al., 2021a). Both studies presented similar data of asymmetry between limbs 12.5% and 11.6%, respectively. The jump squat was performed in 2 studies (Jeras et al., 2020; Ramos et al., 2021). In both studies, the average performance values of the jump squat were lower than the CMJ. Three studies (Bishop et al., 2021; Manson et al., 2014; Pardos-Mainer et al., 2021a) used horizontal jumps in their analyses. However, all performed them unilaterally. The bilateral horizontal jump test was performed only by Bishop et al. (2021).

Another widely used test was the linear sprint to assess the speed of athletes. Among the studies included in the review, 12 of them used this test with different distances analyzed: S5m(Bishop et al., 2021; Hammami et al., 2020; Jeremic et al., 2019), S10m(Bishop et al., 2021; Emmonds et al., 2018; Emmonds et al., 2020; Hammami et al., 2020; Merino-Muñoz et al., 2021; Pardos-Mainer et al., 2021a), S20m (Bishop et al., 2021; Datson et al., 2020; Höner et al., 2019; Jeremic et al., 2019; Pardos-Mainer et al., 2021a; Ramos et al., 2021), S30m (Emmonds et al., 2018; Emmonds et al., 2020; Hammami et al., 2020; Merino-Muñoz et al., 2021; O'Brien-Smith et al., 2020; Pardos-Mainer et al., 2021a), S40m (Pardos-Mainer et al., 2021a), and Vescovi et al. (2011) analyzed the distance in yards.

To assess the ability to change direction, different tests were performed in nine studies (Emmonds et al., 2018; Emmonds et al., 2020; Hammami et al., 2020; Jeremic et al., 2019; Lyle et al., 2015; Merino-Muñoz et al., 2021; O'Brien-Smith et al., 2020; Pardos-Mainer et al., 2021a; Vescovi et al., 2011). 505 COD was performed in 2 investigations (Emmonds et al., 2018; Emmonds et al., 2020), while two other studies performed the 180º COD (Merino-Muñoz et al., 2021; Pardos-Mainer et al., 2021a), which is a modified version of the 505 COD test. Two other studies used the T-test to assess agility (Hammami et al., 2020; O'Brien-Smith et al., 2020). Jeremic et al. (2019) performed the zig-zag agility test, Lyle et al. (2015) used the crossed agility test, and Vescovi et al. (2011) took two different agility tests: Illinois and pro agility.

To assess strength, the maximum voluntary isometric contraction was used in 5 studies (Emmonds et al., 2018; Emmonds et al., 2020; Haag et al., 2016; Lyle et al., 2015; Manson et al., 2014), evaluating it in different ways focusing on lower limb strength. However, Haag et al. (2016) evaluated trunk extension and lateral flexion strength. Two studies evaluated the dynamic balance of athletes, using SEBT by Adigüzel et al. (2020) and its shorter version, the YBT, was used by Haag et al. (2016)

Cardiorespiratory tests were used in 10 studies, the yoyo being the most predominant. test, which was performed in 8 of these studies (Datson et al., 2020; Emmonds et al., 2018; Emmonds et al., 2020; Hammami et al., 2020; Jeremic et al., 2019; O'Brien-Smith et al., 2020; Póvoas et al., 2016; Ramos et al., 2021). YYIR1 was used in all of them. Only Póvoas et al. (2016) used YYIE1 and YYIE2, in addition to YYIR1, which differs in the interval time, being shorter between round trip cycles. Manson et al. (2014) performed another type of cardiorespiratory fitness test: the intermittent fitness test (IFT) 30;15, which consists of walking, in 30 seconds, 40 meters with a passive interval of 15 seconds with an increase in speed at each 40-meter cycle. Furthermore, Romero-Caballero et al. (2021) used the incremental run test (LEGER), which also consists of incremental running over a 20-meter course going back and forth with increments of speed throughout the test.

A wide variety of age groups, including girls between 9 and 17 years old, found in the included studies can be considered as one of the limitations of the present review. In addition, only cross-sectional studies were analyzed. Thus, it was not possible to infer which training methods interfere with the performance of the analyzed tests. In cross-sectional studies, only four were designed to investigate relationships between tests. This limit determining the performance relationship between them, which could provide relevant information to coaches as to which test may interfere with the performance of another. In practical terms, this relationship can reduce the number of tests to be used in the training context, since these interactions can be positively associated. Other limiting factors were the maturational state, the menstrual cycle, the season period, and the playing position of the participants, which were not always informed. Only Emmonds et al. (2020) related the maturational level with test performance.

Conclusion

Most of the analyzed studies were published in the last four years, but with a concentration on the European continent. Neuromuscular tests, especially jump, linear velocity, and change of direction, are more used in the context of soccer practiced by women to determine performance in young athletes, being sensitive in detecting the difference in performance in different age categories. However, tests of cardiorespiratory fitness are used to a lesser extent, with mastery of the YYIR1 and its performance being considered the main test to determine the likelihood of new talent. Nevertheless, no study has investigated the relationship between neuromuscular and cardiorespiratory tests, highlighting the need for further research to investigate these relationships.

Acknowledgements

This research did not receive external funding.

Disclosure statement

absence of any conflict of interest

References

Adigüzel, N., & Koc, M. U. R. A. T. (2020). Comparison of Dynamic Balance Test Scores of Young Female Volleyball and Soccer Players. *International Journal of Applied Exercise Physiology*, *9*(4), 100-104.

Altmann, S., Ringhof, S., Neumann, R., Woll, A., & Rumpf, M. C. (2019). Validity and reliability of speed tests used in soccer: A systematic review. *PloS one*, *14*(8), e0220982. DOI: https://doi.org/10.1371/journal.pone.0220982

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of sports sciences*, *24*(07), 665-674. DOI: https://doi.org/10.1080/02640410500482529

Bishop, C., Read, P., McCubbine, J., & Turner, A. (2021). Vertical and horizontal asymmetries are related to slower sprinting and jump performance in elite youth female soccer players. *The Journal of Strength & Conditioning Research*, *35*(1), 56-63. DOI: 10.1519/JSC.0000000000002544

Bradley, P. S., Di Mascio, M., Peart, D., Olsen, P., & Sheldon, B. (2010). High-intensity activity profiles of elite soccer players at different performance levels. *The journal* *of strength & conditioning research*, *24*(9), 2343-2351. DOI: 10.1519/JSC.0b013e3181aeb1b3

Bush, M., Barnes, C., Archer, D. T., Hogg, B., & Bradley, P. S. (2015). Evolution of match performance parameters for various playing positions in the English Premier League. *Human movement science*, *39*, 1-11. https://doi.org/10.1016/j.humov.2014.10.003

Čović, N., Jelešković, E., Alić, H., Rađo, I., Kafedžić, E., Sporiš, G., McMaster, D. T., & Milanović, Z. (2016). Reliability, Validity and Usefulness of 30-15 Intermittent Fitness Test in Female Soccer Players. *Frontiers in physiology*, *7*, 1-7. https://doi.org/10.3389/fphys.2016.00510

Critical Appraisal Skills Programme (CASP). Cohort Study Checklist. (2018). From http://www.casp-uk.net/casp-tools-checklists.

Datson, N., Hulton, A., Andersson, H., Lewis, T., Weston, M., Drust, B., & Gregson, W. (2014). Applied physiology of female soccer: an update. *Sports Medicine*, *44*, 1225-1240. https://doi.org/10.1007/s40279-014-0199-1

Datson, N., Weston, M., Drust, B., Gregson, W., & Lolli, L. (2020). High-intensity endurance capacity assessment as a tool for talent identification in elite youth female soccer. *Journal of Sports Sciences*, *38*(11-12), 1313-1319. https://doi.org/10.1080/02640414.2019.1656323

Emmonds, S., Till, K., Redgrave, J., Murray, E., Turner, L., Robinson, C., & Jones, B. (2018). Influence of age on the anthropometric and performance characteristics of high-level youth female soccer players. *International Journal of Sports Science & Coaching*, *13*(5), 779-786. https://doi.org/10.1177/1747954118757437

Emmonds, S., Scantlebury, S., Murray, E., Turner, L., Robsinon, C., & Jones, B. (2020). Physical characteristics of elite youth female soccer players characterized by maturity status. *The Journal of Strength & Conditioning Research*, *34*(8), 2321-2328. DOI: 10.1519/JSC.0000000000002795

Emmonds, S., Dalton Barron, N., Myhill, N., Barrett, S., King, R., & Weaving, D. (2023). Locomotor and technical characteristics of female soccer players training: exploration of differences between competition standards. *Science and Medicine in Football*, *7*(3), 189-197. https://doi.org/10.1080/24733938.2022.2089723

Federation International Football Association (FIFA). (2019). Women's football: Member Associations Survey Report. Retrieved October 15, 2022. 4 from nq3ensohyxpuxovcovj0-pdf.pdf (fifa.com).

Garcia-Tabar, I., Rampinini, E., & Gorostiaga, E. M. (2019). Lactate equivalent for maximal lactate steady state determination in soccer. *Research quarterly for exercise and sport*, *90*(4), 678-689. https://doi.org/10.1080/02701367.2019.1643446

Gualtieri, A., Rampinini, E., Dello Iacono, A., & Beato, M. (2023). High-speed running and sprinting in professional adult soccer: current thresholds definition, match demands and training strategies. A systematic review. *Frontiers in Sports and Active Living*, *5*, 1116293. https://doi.org/10.3389/fspor.2023.1116293

Haag, T. B., Schneider, A. S., Beckmann, C., Handel, M., Schneider, C., & Mayer, H. M. (2016). A test battery to investigate back pain in female soccer players. *Sport Sciences for Health, 12,* 361-367. DOI 10.1007/s11332-016-0296-7

Hammami, M. A., Klifa, W. B., Ayed, K. B., Mekni, R., Saeidi, A., Jan, J., & Zouhal, H. (2020). Physical performances and anthropometric characteristics of young elite North-African female soccer players compared with international standards. *Science & Sports*, *35*(2), 67-74. https://doi.org/10.1016/j.scispo.2019.06.005

Höner, O., Raabe, J., Murr, D., & Leyhr, D. (2019). Prognostic relevance of motor tests in elite girls' soccer: a five-year prospective cohort study within the German talent promotion program. *Science and Medicine in Football, 3*(4), 287-296. https://doi.org/10.1080/24733938.2019.1609069

Jeras, N. M., Bovend'Eerdt, T. J., & McCrum, C. (2020). Biomechanical mechanisms of jumping performance in youth elite female soccer players. *Journal of sports sciences*, *38*(11-12), 1335-1341. https://doi.org/10.1080/02640414.2019.1674526

Jeremic, D., Macuzic, I. Z., Vulovic, M., Stevanovic, J., Radovanovic, D., Varjacic, V., & Djordjevic, D. (2019). ACE/ACTN3 genetic polymorphisms and athletic performance of female soccer players. *Revista Brasileira de Medicina do Esporte*, *25*, 35-39. https://doi.org/10.1590/1517-869220192501187684

Junior, M. N. S. D. O., Veneroso, C. E., Passos Ramos, G., Johnson, K. E., Guilkey, J. P., Sena, A. F. D. C., ... & Cholewa, J. M. (2021). Distance and intensity profiles in division i women's soccer matches across a competitive Season. *Sports*, *9*(5), 63. https://doi.org/10.3390/sports9050063

Krustrup, P., Zebis, M., Jensen, J. M., & Mohr, M. (2010). Game-induced fatigue patterns in elite female soccer. *The Journal of Strength & Conditioning Research*, *24*(2), 437-441. DOI: 10.1519/JSC.0b013e3181c09b79

Lyle, M. A., Valero-Cuevas, F. J., Gregor, R. J., & Powers, C. M. (2015). Lower extremity dexterity is associated with agility in adolescent soccer athletes. *Scandinavian journal of medicine & science in sports*, *25*(1), 81-88. https://doi.org/10.1111/sms.12162

Manson, S. A., Brughelli, M., & Harris, N. K. (2014). Physiological characteristics of international female soccer players. *The Journal of Strength & Conditioning Research*, *28*(2), 308-318. DOI: 10.1519/JSC.0b013e31829b56b1

Merino-Muñoz, P., Vidal-Maturana, F., Aedo-Muñoz, E., Villaseca-Vicuña, R., & Pérez-Contreras, J. (2021). Relationship between vertical jump, linear sprint and change of direction in Chilean female soccer players. *Journal of Physical Education and Sport*, *21*(5), 2737-2744. DOI:10.7752/jpes.2021.05364

Modric, T., Versic, S., Sekulic, D., & Liposek, S. (2019). Analysis of the association between running performance and game performance indicators in professional soccer players. *International journal of environmental research and public health*, *16*(20), 4032. https://doi.org/10.3390/ijerph16204032

Modric, T., Versic, S., & Sekulic, D. (2020). Aerobic fitness and game performance indicators in professional football players; playing position specifics and associations. *Heliyon*, *6*(11), e05427. https://doi.org/10.1016/j.heliyon.2020.e05427

O'Brien-Smith, J., Bennett, K. J., Fransen, J., & Smith, M. R. (2020). Same or different? A comparison of anthropometry, physical fitness and perceptual motor characteristics in male and female youth soccer players. *Science and Medicine in Football*, *4*(1), 37-44. https://doi.org/10.1080/24733938.2019.1650197

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International journal of surgery*, *88*, 105906. https://doi.org/10.1016/j.ijsu.2021.105906

Pardos-Mainer, E., Bishop, C., Gonzalo-Skok, O., Nobari, H., Pérez-Gómez, J., & Lozano, D. (2021a). Associations between inter-limb asymmetries in jump and change of direction speed tests and physical performance in adolescent female soccer players. *International journal of environmental research and public health*, *18*(7), 3474-3486. https://doi.org/10.3390/ijerph18073474

Pardos-Mainer, E., Lozano, D., Torrontegui-Duarte, M., Cartón-Llorente, A., & Roso-Moliner, A. (2021b). Effects of strength vs. plyometric training programs on vertical jumping, linear sprint and change of direction speed performance in female soccer players: a systematic review and meta-analysis. *International journal of environmental research and public health*, *18*(2), 401-419. https://doi.org/10.3390/ijerph18020401

Pardos-Mainer, E., Casajus, J., Julian, C., Bishop, C., & Gonzalo-Skok, O. (2020). Determining the reliability and usability of change of direction speed tests in adolescent female soccer players: A systematic review. *The Journal of Sports Medicine and Physical Fitness*, *60*(5), 720-732. 10.23736/S0022-4707.20.10178-6

Park, L. A., Scott, D., & Lovell, R. (2019). Velocity zone classification in elite women's football: where do we draw the lines?. *Science and Medicine in Football*, *3*(1), 21-28. https://doi.org/10.1080/24733938.2018.1517947

Póvoas, S. C., Castagna, C., da Costa Soares, J. M., Silva, P., Coelho-e-Silva, M., Matos, F., & Krustrup, P. (2016). Reliability and construct validity of Yo-Yo tests in untrained and soccer-trained schoolgirls aged 9–16. *Pediatric exercise science*, *28*(2), 321-330. https://doi.org/10.1123/pes.2015-0212

Ramos, G. P., Nakamura, F. Y., Penna, E. M., Mendes, T. T., Mahseredjian, F., Lima, A. M., Garcia, E. S., Prado, L. S., & Coimbra, C. C. (2021). Comparison of Physical Fitness and Anthropometrical Profiles Among Brazilian Female Soccer National Teams From U15 to Senior Categories. *Journal of strength and conditioning research*, *35*(8), 2302–2308. DOI: 10.1519/JSC.0000000000003140

Romero-Caballero, A., Varela-Olalla, D., & Loëns-Gutiérrez, C. (2021). Fitness evaluation in young and amateur soccer players: Reference values for vertical jump and aerobic fitness in men and women. *Science & Sports*, *36*(2), 141-147. https://doi.org/10.1016/j.scispo.2020.04.004

Sarmento, H., Anguera, M. T., Pereira, A., & Araújo, D. (2018). Talent identification and development in male football: A systematic review. *Sports medicine*, *48*, 907-931. https://doi.org/10.1007/s40279-017-0851-7

Sasaki, S., Koga, H., Krosshaug, T., Kaneko, S., & Fukubayashi, T. (2015). Biomechanical analysis of defensive cutting actions during game situations: six cases in collegiate soccer competitions. *Journal of Human Kinetics*, *46*(1), 9-18. 10.1515/hukin-2015-0029

Slimani, M., & Nikolaidis, P. T. (2017). Anthropometric and physiological characteristics of male Soccer players according to their competitive level, playing position and age group: a systematic review. *J Sports Med Phys Fitness*, *59*(1), 141-163. 10.23736/S0022-4707.17.07950-6

Smith, M. R., Thompson, C., Marcora, S. M., Skorski, S., Meyer, T., & Coutts, A. J. (2018). Mental fatigue and soccer: current knowledge and future directions. *Sports Medicine*, *48*, 1525-1532. 10.1007/s40279-018-0908-2

Smith, T. O., Davies, L., De Medici, A., Hakim, A., Haddad, F., & Macgregor, A. (2016). Prevalence and profile of musculoskeletal injuries in ballet dancers: A systematic review and meta-analysis. *Physical Therapy in Sport*, *19*, 50-56. http://dx.doi.org/10.1016/j.ptsp.2015.12.007

Vescovi, J. D., Rupf, R., Brown, T. D., & Marques, M. C. (2011). Physical performance characteristics of high-level female soccer players 12–21 years of age. *Scandinavian Journal of Medicine & Science in Sports*, *21*(5), 670-678. https://doi.org/10.1111/j.1600-0838.2009.01081.x