Range values for external and internal intensity monitoring in female soccer players: A systematic review

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Abstract

Background: The range values of different training and match intensity measures obtained to define benchmarks in female soccer players are needed. Usually, cohort studies analyse only one team with a relatively small sample size, which brings forth the need for a systematic review to generalise training and match intensity evidence.

Objectives: This review aimed to identify and summarise studies that have examined external and internal training or match intensity monitoring to provide range values for the main measures in female soccer players.

Methods: A systematic review of EBSCO, PubMed, Scielo, Scopus, SPORTDiscus and Web of Science databases was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Results: From the 2853 studies searched, 44 were analysed in which the following range intervals were found for training: rated perceived exertion (RPE, 1–7 AU), session-RPE (s-RPE, 51–721 AU), total distance (2347–6646 m) and distance >19.4 km·h^{-1} (9–543 m). For matches, the range values were s-RPE (240–893 AU), total distance (5480–10581 m), distance $\geq$14 km·h^{-1} (543–2520 m), $\geq$ 18 km·h^{-1} (96–1680 m), number of accelerations (49–240) and deceleration (21–85) and player load (848–1096 AU).

Conclusions: This study provides range values of s-RPE, RPE, TRIMP, total distance and distance >19.4 km·h^{-1} regarding training; range intervals of s-RPE, heart rate average and maximum, total distance, distance $\geq$ 14 km·h^{-1}, $\geq$ 18 km·h^{-1}, ACC and DEC (> 2 ms^{-2}) regarding matches for professional female players that can be used by coaches, practitioners or researchers to achieve similar training and competitive levels.

Keywords

Association football, heart rate, match demands, rating of perceived exertion, training load

Introduction

Monitoring training/match intensity in soccer players is currently part of the daily process of sports scientists and strength and conditioning coaches.[1] Coaches and staff perceive intensity monitoring as worthwhile, regardless of the instruments and practices used.[2] One reason for this is that controlling intensity can help coaches and their staff individualise training stimuli, manage recovery strategies and mitigate fatigue and exposure to injury risk or dangerous situations.[3,4]

Usually, training/match intensity is referred as training/match load. However, a recent study suggested that the term 'intensity' would be more appropriate than load according to the 'International System of Units'. Therefore, this systematic review will address this topic using intensity instead of load with the exception for specific measures such as player load.[5]

Intensity is commonly organised into two main dimensions: external; and internal.[6] External intensity represents the mechanical intensity imposed on players by a training

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drill.[7] Tracking systems such as global positioning systems (GPSs) and local positioning systems or inertial measurement units (IMUs) are the most commonly used devices in practice and research for monitoring external intensity demands in soccer.[8] Typical outcomes obtained from these systems are: (i) distances covered at different velocity thresholds; (ii) changes-of-velocity measures such as accelerations (ACC), decelerations (DEC) and changes-of-direction performed at different intensities; and (iii) measures extracted from IMUs, which represent the overall external intensity.[9]

Internal intensity represents the psychophysiological responses to the external intensity.[6] Usually, measurements related to internal intensity are based on heart rate (HR), biochemical factors, or rated perceived exertion (RPE), although HR and RPE are by far the most often used.[8] Although they are not perfectly correlated, internal and external intensity can be significantly correlated, depending on the measurements considered in an analysis.[10]

Although training and match intensity monitoring are well-established research topics in sports sciences,[11] especially in soccer,[12] there is still a gap between genders. Most of the research involving intensity monitoring is focused on men, ranging from youth[13] to professional[14] players. However, over the past decade, there has been an exponential rise in the participation and professionalisation of female athletes.[15] This fact requires additional research in the field of external and internal intensity to provide useful information for coaches and identify the best practices for this population.[15]

Aside from improving the technical and tactical skills, players must be prepared to tolerate higher physical demands and intensities at each competition level. Therefore, an understanding of match demands will aid coaches and practitioners in creating appropriate training plans. The proper application of available evidence from female soccer matches should improve players' performance. In recent years, descriptive studies presenting some typical/normative values of intensity in different periods of the season (or based on playing positions) have been published.[16,17]

It is essential that these data are collected and interpreted correctly to inform decisions concerning training intensity management.[18] Although there is a consistent body of knowledge about training demands in male soccer players, there is a lack of similar knowledge in female players, as mentioned in a recent systematic review about locomotor demands monitoring in soccer.[19] In one such systematic review, less than 10% of the included studies about arbitrary speed zones involved females, while less than 5% addressed individualised speed zones.[19] A possible consequence of this lack of research is that practitioners had to apply evidence developed on male soccer players to female soccer players, which could be inappropriate.[20] It is critical, therefore, that data are collected from female

soccer players and interpreted correctly to allow for effective decision-making related to intensity planning and periodisation.[15]

The lack of evidence about intensity in female training sessions is not unique. Similarly, although more studies have focused on female match demands recently, there are still fewer studies on females than on males. A simple search on PubMed performed at January 29 of 2022 using the code line [("soccer")AND("match demand*" OR "load*") AND("male*"OR"men*")] and [("soccer")AND("match demand*" OR "load*")AND("female*"OR"women*")] yielded 130 publications on males and 56 on women published in the year 2021; overall, the search produced 771 publications on men and 280 on women. This means that both training and match demands have been researched less often in females than males. Despite such a bias, growing evidence can help provide range values that sports scientists and researchers can use to better define guidelines for practice or for research. In the case of research on females, although values have been reported in some cohorts,[16,17] limitations related to sample size and the fact that most studies consider only one team restrict the generalisability of the evidence.

In addition to the importance of increasing the sample size and number of teams, there is a need to identify the typical values of different training and match intensity measures obtained per session or per week to define benchmarks or provide a range of predicted intensity scenarios in the season. One way to identify such values is to summarise the evidence from different studies conducted in women soccer regarding intensity monitoring. This may help to characterise ranges of expected values and help practitioners.

However, as far as we know, no systematic review has been conducted on this topic so far. Thus, this systematic review aims to identify and summarise studies that have examined external and internal training/match intensity monitoring in female soccer players and provide range values for the main measures. This summary may provide range values that will help coaches determine benchmarks for acceptable values of load and compare their players' training and match demands with those of similar players from the same population.

Methods

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines were followed to write this systematic review[21] and guidelines for performing systematic reviews in sport sciences.[22] The protocol of the systematic review was a priori registered in INPLASY (International Platform of Registered Systematic Review and Meta-Analysis Protocols) with the identification number INPLASY202170010 and the DOI 10.37766/inplasy2021.7.0010.

Eligibility criteria

The inclusion and exclusion criteria can be found in Table 1.

The screening process related to analysis of the title, abstract and reference list of each article to locate potentially relevant studies was independently executed by two of the authors (AMV and MRG). Moreover, both authors also reviewed the full version of the included papers in detail to identify which article met the inclusion criteria. Additionally, a search within the reference lists of the included records was performed to add additional relevant studies. In the cases of discrepancies, a discussion was performed with the participation of a third author (RO). Possible errata for the included articles were considered.

Information sources

The following electronic databases were used to search for relevant publication on 31 of July 2021, after protocol registration: FECYT (MEDLINE, Scielo, and Web of Science), PubMed, and Scopus. A manual search was also conducted after search in electronic databases to retrieve additional studies that could fit our eligibility criteria.

Search strategy

Keywords and synonyms were entered in various combinations in the title, abstract or keywords: ("soccer" OR "football") AND ("female" OR "women") AND ("internal load" OR "external load" OR "workload" OR "training load" OR "training demands" OR "match" OR "matches" OR "game*" OR "load monitoring"). Search results were exported to EndNote 20.0.1 for Mac (Clarivate Analytics). No filters or limits were applied.

Data extraction

A specific spreadsheet was designed in Microsoft Excel (Microsoft Corporation, Readmon, WA, USA) to process the data extraction. The design followed the recommendations of the Cochrane Consumers and Communication Review Group's data extraction template.[23] In this spreadsheet, the information about inclusion and exclusion requirements and reasons was detailed. The selection of the articles was made independently by two authors (AMV and MRG). In the cases of discrepancies, a discussion was performed with the participation of a third author (RO).

Methodological assessment

The methodological quality was assessed using the methodological index for non-randomized studies (MINORS) by two independent authors (AMV and MRG).[24] The global ideal score being 16 for non-comparative studies. MINORS consists of 12 items, four of which are only

Table 1. Eligibility criteria.

PICOS	Inclusion criteria	Exclusion criteria
1 – Population	Healthy female soccer players from any age or competitive level.	Other sports. Male populations. Players with injury or illness. Physical education students.
2 – Intervention/ Exposure	Exposure to entire training sessions for a minimum of one week and/or exposure for an entire match (more than one official or non-official match).	No exposure to training sessions or matches.
3 – Comparator	Not required. Eventually, comparisons between playing positions and/or competitive levels within the same age-group and/or age-groups.	No study will be excluded on the basis of comparators.
4 – Outcomes	Presents at least of one measure of internal intensity (e.g. heart rate, rated perceived exertion) and/or one measure of external intensity (e.g. distances covered at different speed thresholds, acceleration-based measures) in absolute values.	Absence of data characterizing the intensity during the training/match sessions (e.g. wellness variables, readiness parameters) and/or only reports the data in relative values without allowing the calculation of absolute values. Data from work intensity calculations will also be excluded (e.g. accumulated weekly intensity, training monotony, strain, acute chronic workload ratio, exponentially weighted moving average). Data from percentage or duration for external and internal intensity measures will also be excluded.
5 – Study design	No restrictions imposed on study design.	No study was excluded on the basis of study design.
6 – Others	Only original and full-text studies written in English.	Written in other language than English. Other article types than original (e.g. reviews, letters to editors, trial registrations, proposals for protocols, editorials, book chapters and conference abstracts).

PICOS: (P) population; (I) intervention/exposure; (C) comparator; (O) outcomes; (S) study design.

applicable to comparative studies which was not the case of the included studies. Thus, only eight items were applied. Each item is rated as 0 when the criterion is not reported in the article, 1 if reported but not sufficiently fulfilled, or 2 when adequately met. Higher scores indicate good methodological quality of the article and low risk of bias. The highest possible score is 16 for non-comparative studies. MINORS has yielded acceptable inter- and intra-rater reliability, internal consistency, content validity and discriminative validity.[24,25]

Results

Study identification and selection

A total of 2853 original articles (FECYT: 1429; PubMed: 608; Scopus: 816) were initially retrieved, of which 1142 were duplicates. Thus, a total of 1711 original articles were found. After this, 1661 articles were excluded after their titles and abstracts were checked. Furthermore, six of the initially excluded articles were retrieved for further analysis, of which one was excluded. The full texts of the remaining 55 articles were checked, leading to the exclusion of another nine articles according to criterion #1 and seven more according to criterion #2. Additionally, five articles were included from additional sources. Ultimately, 44 articles met all the inclusion criteria and were included in the qualitative synthesis. All the steps followed for selecting articles are listed in Figure 1.

Methodological quality

The overall methodological quality of the cross-sectional studies can be found in Table 2.

Results of the studies

Study characteristics

Table 3 presents the characteristics of the studies. From the 44 studies included, only three included young soccer players.[53,63,66] Eight studies included amateur players,[27,34,42,53,57,60,63,66] while the remaining 35 studies included professional soccer players.

Thirty studies analysed matches,[26–28,30–32,36–38,40–43,46,49–52,55–63,65,67] eight studies analysed training sessions[16,17,29,33,34,39,64,66] and five studies analysed both matches and training sessions.[35,44,48,53,54]

Six studies analysed internal measures,[17,29,33,39,64,66] 25 studies analysed external measures[28,30–32,36–38,41,42,44,46,49,50,52–59,61–63,65] and 10 studies analysed both internal and external measures.[16,26,27,35,40,43,48,51,60,67].

Results of internal and external training/match intensity

Table 4 presents the results for internal and external intensity. In the last rows of Table 4, we present the range intervals for the main measures used for internal and external measures.

Table 5 presents the results of external and internal match intensity as averages ± standard deviation or range intervals (minimum and maximum). To avoid including more rows, Table 6 also includes a column designed as 'overall team' that contains information from studies that analysed playing positions. In the last line of Table 5, we present the range interval for the main measures used for internal and external measures.

Table 6 presents the results for external training and internal and external match intensity by playing position. To improve the clarity and interpretation of the table, we organised the table from training to match intensity according to playing positions as defined by each study, which resulted in different divisions.

Finally, an additional column for the overall team was added with the corresponding values reported by the studies or the range values between playing positions (excluding goalkeepers' data). In Table 6, no range interval was provided since there were diverse contexts and different determinations of playing positions.

Discussion

This systematic review aimed to identify and summarise studies that had examined external and internal training or match intensity monitoring in female soccer players and provide range values for the main training and match measures. The scientific research and screening steps focused primarily on papers that have quantified external or internal measures with at least one training week or more than two matches. Contextual factors such as the relationship with injuries, type of training session or competition, period of the season, match period (first and second halves), match status and playing positions were obtained in the research.

This section, which addresses all the findings, was organised into the following subsections: training intensity (internal and external) by overall team and by playing position and match intensity (internal and external) by overall team and by playing position.

Training intensity

Training intensity, as mentioned above, is often described as either external or internal[68,69] and can be manipulated to promote favourable adaptive responses to training.[6] Athlete monitoring allows practitioners to access

Identification of studies via databases and register

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Identification

Records identified from*:
    Databases (n = 2853)
    - FECYT (n = 1429)
    - PubMed (n = 608)
    - Scopus (n = 816)

    Registers (n = 5)
```
→
```
Records removed before screening:
    Duplicate records removed (n = 1142)
    Records marked as ineligible by
    automation tools (n = 0)
    Records removed for other reasons (n = 0)
```

```
Screening

Records screened
(n = 1716)
```
→
```
Records excluded**
(n = 1661)
```

```
Reports sought for retrieval
(n = 6)
```
→
```
Reports not retrieved
(n = 1)
```

```
Reports assessed for eligibility
(n = 60)
```
→
```
Reports excluded:
    (i) Only one match = 9
    (ii) Not entire training sessions = 7
```

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Included

Studies included in review
(n = 44)
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Figure 1. Preferred reporting item for systematic reviews and meta-analyses (PRISMA) flow diagram.

information to determine whether athletes are responding appropriately to training and match demands.[70] In this way, coaches and practitioners can try to minimise the risk of excessive intensity and optimise athletic performance.[71]

Internal intensity is often referred to as the psycho-physiological stressors imposed on an athlete due to the prescription of external physical stimuli.[6,70] Measurements of internal intensity can be subjective or objective.[6]

According to the rationale described above, the present systematic review yielded five studies that allowed data extraction from the main findings regarding internal intensity measured by session rated perceived exertion (s-RPE),[16,29,35,64,66] which presented a range interval of 51–721 arbitrary units (AU), a mean of 440 AU without injury and $\geq$ 517 AU with higher injury risk.[66]

Even considering the mandatory confinement due to the COVID-19, a mean of 489 AU was reported.[64] The s-RPE values reported by Watson et al.[66] were related to an amateur squad team. Amateur teams usually have fewer training sessions per week than professional teams, which may influence the coach's intensity prescriptions and player perceptions.

Moreover, one study addressed player status and positions.[16] The authors found that on match-day minus two, starters reported significantly higher s-RPE, while playing position showed differences in all training sessions.[16]

Previously, s-RPE showed significant correlations ($p <$ 0.001) with all training activities in female soccer players and appears to be a robust measure to be considered in daily training.[72] An essential recommendation for practitioners and coaches to ensure reliability and validity of

Table 2. Methodological assessment using MINORS checklist.

Study	1	2	3	4	5	6	7	8	Score
[26]	2	2	1	2	0	2	2	2	13/16
[27]	2	2	2	2	1	2	2	2	15/16
[28]	2	2	2	2	1	1	2	2	14/16
[29]	2	2	2	2	1	2	2	2	15/16
[30]	2	2	2	2	1	2	2	1	14/16
[31]	2	2	2	2	0	2	2	1	13/16
[32]	1	2	2	1	2	1	2	1	12/16
[16]	2	2	2	2	1	1	2	2	14/16
[33]	2	2	2	2	1	2	2	2	15/16
[34]	2	2	2	2	1	2	2	2	15/16
[35]	2	2	2	2	0	2	2	2	14/16
[36]	2	2	2	2	1	2	2	2	15/16
[37]	1	2	2	1	2	1	2	1	12/16
[38]	2	2	1	2	1	0	2	1	10/16
[39]	2	2	1	2	1	1	2	1	12/16
[40]	2	2	2	2	0	2	2	2	14/16
[41]	1	2	2	2	0	1	2	1	11/16
[42]	2	2	2	2	1	2	2	1	14/16
[43]	2	2	1	2	2	2	2	1	14/16
[44]	2	2	2	2	2	2	2	2	16/16
[45]	2	2	2	2	2	1	2	2	15/16
[46]	2	2	2	2	1	2	2	2	15/16
[47]	2	2	2	2	2	2	2	2	16/16
[48]	2	2	2	2	1	1	2	2	14/16
[49]	2	2	2	2	1	2	2	2	15/16
[50]	2	2	2	2	0	2	2	2	14/16
[51]	2	2	2	2	0	2	2	2	14/16
[52]	2	2	2	2	1	0	2	2	13/16
[53]	2	2	2	2	1	1	2	1	13/16
[54]	2	2	2	2	1	2	2	1	14/16
[55]	2	2	2	2	1	2	2	2	15/16
[56]	2	2	2	2	1	2	2	2	15/16
[57]	2	2	2	2	1	1	2	1	13/16
[58]	2	2	2	2	1	2	2	2	15/16
[59]	2	2	2	2	1	2	2	2	15/16
[60]	2	2	2	2	1	2	2	2	15/16
[61]	2	2	2	2	0	1	2	1	12/16
[62]	1	2	1	1	0	2	2	1	10/16
[63]	2	2	2	2	0	2	2	1	13/16
[64]	2	2	2	2	0	1	2	2	13/16
[17]	2	2	2	2	1	2	2	2	15/16
[65]	2	2	2	2	1	2	2	2	15/16
[66]	2	2	2	2	1	2	2	2	15/16
[67]	2	2	2	2	1	2	2	2	15/16

Note: *The MINORS checklist asks the following information (2 = High quality; 1 = Medium quality; 0 = Low quality):
1. Clearly defined objective.
2. Inclusion of patients consecutively.
3. Information collected retrospectively.
4. Assessments adjusted to objective.
5. Evaluations carried out in a neutral way.
6. Follow-up phase consistent with the objective.
7. Dropout rate during follow-up less than 5%.
8. Appropriate statistical analysis.

the s-RPE measure is to use standardised instructions and allow for an anchoring procedure to familiarise the athlete with the s-RPE scale.[73]

When training duration was not considered, the RPE values reported by the players varied between 3 ± 1 (1–6) AU in the study by Costa et al.[29] which is similar to the

Table 3. Study characteristics.

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
26	17	27 ± 1	Professional	Match	3 domestic league matches and 3 international matches Match duration: 90 min	HR monitor Team system; Polar Electro OY, Kempele, Finland: HR (bpm) HRpeak (bpm)	Canon DM-MV 600, Canon Inc., Tokyo, Japan: Total distance (m) Distance ≥ 8 km·h⁻¹ (m) Distance ≥ 25 km·h⁻¹ (m)
27	11	19 ± 1	Amateur	Match	1 full-season Match duration out of conference: 80 ± 17 min Match duration in conference: 90 ± 15 min	Polar TeamPro HR (Polar Electro Co., Woodbury, NY): TL-HR/GPS based metric (TL/min) 80–89% HRmax (min) 90–100% HRmax (min)	Polar TeamPro HR (Polar Electro Co., Woodbury, NY): Total distance (m) Distance 15.0–19.9 km·h⁻¹ (m) Distance ≥ 20 km·h⁻¹ (m) ACC ≥ 2.8 ms⁻² (NR)
28	49	ND	Professional	Match	Middle and end of in-season Match duration: 45–90 min	–	TL-HR/GPS based metric multi-camera system (Amisco, Nice, France) Distance 0–12 km·h⁻¹ (m) Distance 12–15 km·h⁻¹ (m) Distance 15–18 km·h⁻¹ (m) Distance 18–21 km·h⁻¹ (m) Distance 21–23 km·h⁻¹ (m) Distance 23–25 km·h⁻¹ (m) Distance 25–27 km·h⁻¹ (m) Distance >27 km·h⁻¹ (m)
29	17	21 ± 2	Professional	Training	6 in-season weeks (18 training days) Training duration: 96 min	Firstbeat Sports, Finland); HRpeak RPE (CR-10, AU) s-RPE (CR-10, AU) Banister TRIMP (AU) HRpeak (%) > 90% HRpeak (%)	–
30	107	ND	Professional	Match	2 full-seasons Match duration: 90 min	–	Prozone Sports Ltd, Leeds, UK: Total distance (m) Distance 0.7–7.1 km·h⁻¹ (m) Distance 7.2–14.3 km·h⁻¹ (m) Distance 14.4–19.7 km·h⁻¹ (m) Distance 19.8–25.1 km·h⁻¹ (m) Distance >25.1 km·h⁻¹ (m)

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
31	107	ND	Professional	Match	2 full-seasons Match duration: 90 min	–	Distance >14.4 km·h⁻¹ (m) Distance >19.8 km·h⁻¹ (m) GPS STATS, Leeds, England Distance 19.8–25.1 km·h⁻¹ (m) Distance >25.1 km·h⁻¹ (m)
32	18	25 ± 3	Professional	Match	20 matches in the NWSL in-season Match duration: 90 min	–	Catapult Optimeye S5 monitor (Catapult Innovations, Melbourne, Australia): Total distance (m) Distance >17.8 km·h⁻¹ (m) NR Distance >17.8 km·h⁻¹ (m) NR Distance > 22.7 km·h⁻¹ (m) Player intensity (AU)
16	18	24 ± 4	Professional	Training	1 international training camp week Training duration: 58–103 min	RPE (CR-10, AU) s-RPE (CR-10, AU)	18 Hz GPS (Apex, Statsport, Newry) Total distance (m) Distance 19–22.5 km·h⁻¹ (m) Distance > 22.5 km·h⁻¹ (m) Distance > 22.5 km·h⁻¹ (NR) ACC > 3 ms⁻² DEC >3 ms⁻²
33	8	20 ± 2	Professional	Training	2 Preseason weeks Training duration: 90–120 min	Polar Team2 (VantageNV; Polar Electro, Kempele, Finland, Europe): HR (bpm) TRIMP (AU)	–
34	10	22 ± 2	Amateur	Training	2 weeks Match duration: 90 min	App (HRV Fit Ltd Southampton, UK) (Non-Coded Polar T-31, Polar Electro Oy, Kemple, Finland) s-RPE (CR-10, AU)	–
35	25	20 ± 1	Professional	Match and training	1 full-season (17 matches and 24 sessions) Match duration: 117 ± 12 Training duration: 76 ± 17 min	s-RPE (CR-10, AU) RPE (CR-10, AU)	5 Hz GPS units (BT-Q1300ST GPS, Qstarz International Co, Taipei, Taiwan): Total Distance (m) Distance 1.0–4.99 km·h⁻¹ (m) Distance 5–9.99 km·h⁻¹ (m) Distance 10–14.99 km·h⁻¹ (m) Distance 15–19.99 km·h⁻¹ (m)

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
36	22	25 ± 7	Professional	Match	22 Weeks Match duration: 90 min	–	Distance 20–24.99 km·h⁻¹ (m) Distance ≥ 25 km·h⁻¹ (m) GPS (SPI HPU, GPSports, Canberra, Australia): Total distance (m) Distance 0–5.9 km·h⁻¹ (m) Distance 6–11.9 km·h⁻¹ (m) Distance 12–13.9 km·h⁻¹ (m) Distance 14–17.9 km·h⁻¹ (m) Distance 18–23.9 km·h⁻¹ (m) Distance >24 km·h⁻¹ (m) ACC 1–1.9 ms⁻² (NR) ACC 2–2.9 ms⁻² (NR) ACC 3–4 ms⁻² (NR) DEC 1–1.9 ms⁻² (NR) DEC 2–2.9 ms⁻² (NR) DEC 3.4 ms⁻² (NR) Maximal speed (km·h⁻¹) Distance > 24 km·h⁻¹ (NR)
37	15 18	Domestic 26 ± 3 International 26 ± 4	Professional	Match	2 full-seasons Match duration: 90 min	–	VX Sport, GPSports 10 Hz: Total distance (m) Distance 16–20 km·h⁻¹ (m) Distance > 20 km·h⁻¹ (m)
38	15	24 ± 1	Professional	Match	13 international matches Match duration: 90 min	–	MinimaxXv2.5, Catapult, Melbourne, Australia: Total distance (m) Distance 12–19 km·h⁻¹ (m) Distance > 19 km·h⁻¹ (m)
39	27	24 ± 5	Professional	Training	5 in-season months (46 sessions) Training duration: 90 min	HR telemetric systems (Suunto Team Manager 2.1.2VR and Suunto Team Monitor 2.1.1V): HR (bpm)	-
40	25	20 ± 1	Professional	Match	22 official matches Match duration: ≥45 min	Polar TeamProTM Polar Electro, Oy, Kempele, Finland): HR (bpm) HRavg (bpm) s-RPE (CR-10, AU)	10 Hz GPS (Polar TeamProTM Polar Electro, Oy, Kempele, Finland): Acc / Dec: ± 0.5–1.99 ms⁻²; ± 2.00–2.99 ms⁻²; ± 3.00–50.0 ms⁻² (NR) Distance <6.99 km·h⁻¹ (m) Distance 7.0–14.99 km·h⁻¹ (m) Distance 15.0–18.99 km·h⁻¹ (m)

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
41	83	23 ± 4	Professional	Match	4-month in-season Match duration: ≥75 min	—	Distance >19.00 km·h⁻¹ (m) Distance NR >10.08 km·h⁻¹ (m) 5Hz GPS (Tracktics TT01, Hofheim, Germany): Total distance (m) Distance < 13.20 ± 0.71 km·h⁻¹ (m) Distance 13.20 ± 0.71–16.69 ± 1.09 km·h⁻¹ (m) Distance 16.69 ± 1.09–19.94 ± 0.88 km·h⁻¹ (m) Distance > 19.94 ± 0.88 km·h⁻¹ (m) Distance 13.20–19.24 km·h⁻¹ (NR) Distance > 19.94 ± 0.88 km·h⁻¹ (NR)
42	18	19 ± 1	Amateur	Match	13 matches observation Match duration: 90 min	—	10 Hz GPS Polar Team Pro® (Polar Electro, Kempele, Finland): Distance 1.0–5.99 km·h⁻¹ (m) Distance 6.0–10.99 km·h⁻¹ (m) Distance 11.0–15.49 km·h⁻¹ (m) Distance 15.5–19.9 km·h⁻¹ (m) Distance > 20 km·h⁻¹ (m) Distance NR > 20 km·h⁻¹ (m) Total distance (m)
43	14	24 (19–31)	Professional	Match	3-weeks in the middle of the in-season Match duration: ND	Polar Vantage NV HR monitor (Polar Electro Oy, Kempele, Finland) HR (bpm)	NV-M50, Panasonic, Germany: Distance 0 km·h⁻¹ (m) Distance 6 km·h⁻¹ (m) Distance 8 km·h⁻¹ (m) Distance 12 km·h⁻¹ (m) Distance 15 km·h⁻¹ (m) Distance 18 km·h⁻¹ (m) Distance 25 km·h⁻¹ (m)
44	8	23-30	Professional	Training and Match	7 consecutive days (4 training sessions and a friendly game) Training duration: 110 min Match duration: 60 min	—	15 Hz GPS (SPI HPU, GPSports Systems, Canberra, Australia): Total distance (m) Distance 12.2–19.1 ms⁻² (m) Distance >19.4 ms⁻² (m) ACC > 2 ms⁻² (NR) DEC > −2 ms⁻² (NR)

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
45	17	ND	Professional	Training	1 full-season Training duration: ND	–	15 Hz GPS (SPI HPU, GPSports Systems, Canberra, Australia): Total distance (m) Distance >12.24 km·h⁻¹ (m) Distance > 19.44 km·h⁻¹ (m) ACC > 2 ms⁻² DEC < −2 ms⁻²
46	12	24 ± 4	Professional	Match	7 official matches Match duration: 90 min	–	8 stationary high-definition video cameras (Legria HF R38; Canon, Tokyo, Japan): Total distance (m) Distance 12.2–19.1 km·h⁻¹ (m) Distance >19.4 km·h⁻¹ (m)
47	16	23 ± 2	Professional	Match	2 matches (home and away) Match duration: 90 min	s-RPE (CR-10, AU)	-
48	21	20 ± 2	Professional	Training and Match	16 in-season weeks (21 matches and 63 sessions) Match and training duration: non-described	Polar TeamPro system (Polar Electro Co., Woodbury, NY, USA): HR (bpm)	Polar TeamPro system (Polar Electro Co., Woodbury, NY, USA): TL-HR/GPS based metric Total distance (m)
49	34	ND	Professional	Match	1 or 2 matches Match duration: 90 min	-	NV-M50, Panasonic, Germany: Total distance (m) Distance > 18 km·h⁻¹ (m) Distance > 25 km·h⁻¹ (m) Distance 18 km·h⁻¹ (NR) Distance 25 km·h⁻¹ (NR)
50	11	21 ± 3	Professional	Match	10 official matches Match duration: 90 min	–	5-Hz GPS (SPI Elite, GPSports Systems, Australia): NR Distance > 20 km·h⁻¹ (m) Distance > 20 km·h⁻¹ (m)
51	94	23 ± 4	Professional	Match	First half of 1 in-season Match duration: 90 min	10 Hz Polar Team Pro: HRavg (bpm) HRmax (bpm)	10-Hz Polar Team Pro: Total distance (m) Distance >25 km·h⁻¹ (m) Distance >15 km·h⁻¹ (m) Distance >18 km·h⁻¹ (m)

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
52	27	25 ± 4	Professional	Match	3 full-seasons 52 official matches Match duration: ≥45 min	—	Maximal speed (km·h⁻¹) ACC (NR) DEC (NR) 10-Hz GPS devices (MinimaxX S4, Catapult 179 Sports, Australia): Distance <14.4 km·h⁻¹ / <12 km·h⁻¹ / ≥12 km·h⁻¹ (m) Distance ≥14.4–19.8 km·h⁻¹ / ≥12–15.9 km·h⁻¹ (m) Distance ≥19.8–25.2 km·h⁻¹ / ≥16–19.9 km·h⁻¹ (m) Distance ≥25.1 km·h⁻¹ / ≥20 km·h⁻¹ (m)
53	21	26 ± 4	Professional	Training and match	30-day preparatory training camp 22 training sessions Official Match duration: 94 min Friendly match duration: 24 min Technical training: 46 min	—	MinimaxX GPS units; Team S5, Catapult Innovations, Melbourne, Australia: Distance 0–6 km·h⁻¹ (m) Distance 6–8 km·h⁻¹ (m) Distance 8–12 km·h⁻¹ (m) Distance 12–15 km·h⁻¹ (m) Distance 15–20 km·h⁻¹ (m) Distance > 20 km·h⁻¹ (m) ACC (NR) DEC (NR)
54	23	28 ± 5	Professional	Training and Match	23 matches Match duration: non described	—	10-Hz GPS (Polar Team Pro, Polar Electro, Kempele, Finland): Total distance (m) DC: ≤ 12 km·h⁻¹ (m) DC: 12 to 15.9 km·h⁻¹ (m) DC: 16 to 19.9 km·h⁻¹ (m) Sprint: ≥ 19.9 km·h⁻¹ (m) ACC ≥ 2.00 ms⁻² ACC 1.0–1.99 ms⁻² DEC ≤ −2.00 ms⁻² DEC −1.0–1.99 ms⁻²

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
55	12	18 ± 0.7	Professional	Match	7 official matches Match duration: 90 min	–	10-Hz MinimaxX GPS units; Team S5, Catapult Innovations, Melbourne, Australia: Distance 15.6–20 km·h^{-1} (m) Distance > 20 km·h^{-1} (m) Total distance (m) ACC > 2 ms^{-2} (NR) DEC > – 2 ms^{-2} (NR) Player intensity (AU)
56	U17 = 14 U20 = 14 Senior = 17	16 ± 1 18 ± 1 27 ± 5	Amateur and Professional	Match	6–7 official international matches Match duration: 90 min	–	10 Hz MinimaxX GPS units; Team S5, Catapult Innovations, Melbourne, Australia: Total distance (m) Distance 15.6–20 km·h^{-1} (m) Distance >20 km·h^{-1} (m) ACC >1 ms^{-2} (NR) DEC >–1 ms^{-2} (NR) Player intensity (AU)
57	23	21 ± 1	Amateur	Match	4 full-seasons Match duration: 90 min	–	10-Hz Catapult Sports, Melbourne, Australia: Total distance (m) Distance >15 km·h^{-1} (m) Distance >18 km·h^{-1} (m)
58	136	24 ± 4	Professional	Match	2 seasons 220 matches Match duration: $\geq 5 \times 90$ min	–	10-Hz GPS; Optimeye S5, Catapult Sports, Melbourne: Distance ≥ 10.8 km·h^{-1} (m) Distance ≥ 19 km·h^{-1} (m) Distance ≥ 22.5 km·h^{-1} (m)
59	220	25 ± 3	Professional	Match	2 in-season periods Match duration $\geq$90 min	–	10-Hz GPS; Optimeye S5, Catapult Sports, Melbourne: Total distance (m) Distance $\geq$12.5 km·h^{-1} (m) Distance $\geq$19.0 km·h^{-1} (m) Distance $\geq$22.5 km·h^{-1} (m) Maximal Speed km·h^{-1} (m)

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
60	30	23 ± 2	Amateur	Match	1 tournament 84 individual match files Match duration: 70 min	Fix Polar Heart Rate Transmitter Belt (Polar Electro, Kempele, Finland): HRmax (bpm)	10-Hz GPS MinimaxX S4 V4.0, Catapult Innovations, Victoria, Australia: Total distance (m) Distance <11.88 km·h^{-1} (m) Distance 12.24–15.48 km·h^{-1} (m) Distance >16.2 km·h^{-1} (m) Player intensity (AU)
61	45	ND	Professional	Match	55 international fixtures across 5 years Match duration: 90 min	–	10-Hz GPS Minimax S4, Catapult Innovations, Australia: Total distance (m) Distance >19.98 km·h^{-1} (m) Distance >19.98 km·h^{-1} (NR) ACC (m) Distance >16.48 km·h^{-1} (NR) Player intensity (AU)
62	71	ND	Professional	Match	12 regular season matches Match duration: 90 min	–	5-Hz GPS SPI Pro, GPSports, Canberra, Australia: Distance >25 km·h^{-1} (m)
63	89 U15 n=11 U16 n=63 U17 n=15	U15 U16 U17	Amateur	Match	1 tournament or camp Match duration: 40 min for U15 and U16 or 45 min for U17	–	5-Hz GPS SPI Pro, GPSports, Canberra, Australia: Total distance (m) Distance 0–6.0 km·h^{-1} (m) Distance 6.1–8.0 km·h^{-1} (m) Distance 8.1–12.0 km·h^{-1} (m) Distance 12.1–15.5 km·h^{-1} (m) Distance 15.6–20.0 km·h^{-1} (m) Distance > 20.0 km·h^{-1} (m) Distance > 20.0 km·h^{-1} (NR) Maximal speed (km·h^{-1})
64	32	26 ± 4	Professional	Training	24-week period Preparatory training: 86 min Confinement period: 88 min	s-RPE (CR-10, AU)	–

(continued)

Table 3. (continued)

Study	N	Age	Competition level	Condition	Study and training/match duration	Internal measures and instruments	External measures and instruments
17	25	20 ± 1	Professional	Training	2 full-season	Polar S610 heart rate monitor Polar Electro Co., Woodbury, NY, USA: HR (bpm) s-RPE (CR-10, AU)	–
65	9	21 ± 1	Professional	Match	regular-season and post-season competitions (Regular season n = 17; post-season n = 4) Match duration: 58–95 min	–	10-Hz GPS MinimaxX 4.0, Catapult Systems, Victoria, Australia: Distance 0–1.98km·h⁻¹ (m) Distance 1.99–6.95 km·h⁻¹ (m) Distance 6.96–8.96 km·h⁻¹ (m) Distance 8.97–12.99 km·h⁻¹ (m) Distance 13.0–15.95 km·h⁻¹ (m) Distance 15.96–21.9 km·h⁻¹ (m) Distance ≥ 22.0 km·h⁻¹ (m) Distance < 13 km·h⁻¹ (m) Distance ≥ 13 km·h⁻¹ (m) Maximal speed km·h⁻¹ (AU) Player intensity (AU)
66	75	165 ± 2	Amateur	Training	20 in-season weeks Training duration: non-described.	s-RPE (CR-10, AU)	-
67	25	19 ± 1	Professional	Match	2 full-seasons Match duration: 90 min	HR monitor (T34, Polar, Bethpage, NY, USA): HRavg (bpm) HRexertion (AU)	15Hz GPS system (SPI HPU, GPSports, Canberra, Australia): Total distance (m) HMLD (>20 W·kg⁻¹) Speed exertion (AU)

ND: non-described; HR: heart rate; NR: number; DC: distance covered; TL-HR/GPS: training intensity based on HR and GPS metrics; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; GPS: global positioning system; HRavg: average heart rate; HRmax: heart rate maximum; bpm: beats per minute; HSR: high-speed running; VHSR: very high-speed running; ACC: acceleration; DEC: deceleration; HMLD: high metabolic intensity distance; AU: arbitrary units.

Table 4. Results for internal and external training intensity.

Study	Level	Internal intensity	Overall team	External intensity	Overall team
29	P	RPE (CR-10, AU) s-RPE (CR-10, AU) Banister TRIMP (AU)	3 ± 1 (1–6) 338 ± 107 (112–656) 212 ± 81 (67–498)	–	–
16	P	RPE (CR-10, AU) s-RPE (CR-10, AU)	1–7 51–721	Total distance (m) Distance 19–22.5 km·h⁻¹ (m) Distance >22.5 km·h⁻¹ (m) Distance >22.5 km·h⁻¹ (NR) ACC > 3 ms⁻² (NR) DEC >3 ms⁻² (NR)	2916–6387 9–543 0–321 0–64 17–72 14–64
33	P	Banister TRIMP (AU)	185 ± 43	–	–
34	A	s-RPE (CR-10, AU)	333 ± 117–1232 ± 164	–	–
35	P	s-RPE (CR-10, AU)	143 ± 124	Distance 1.0–4.99 km·h⁻¹ (m) Distance 5–9.99 km·h⁻¹ (m) Distance 10–14.99 km·h⁻¹ (m) Distance 15–19.99 km·h⁻¹ (m) Distance 20–24.99 km·h⁻¹ (m) Distance ≥25 km·h⁻¹ (m) Total Distance (m) Player Intensity (NR.s)	1300 ± 440 1000 ± 400 470 ± 250 150 ± 130 30 ± 70 0 ± 10 2950 ± 950 12410 ± 4067
39	P	HRmax (bpm)	126–162	–	–
44	P	-	-	Total distance (m) Distance 12.2–19.1 ms⁻² (m) Distance >19.4 ms⁻² (m) ACC > 2 ms⁻² (NR) DEC > −2 ms⁻² (NR)	6581 ± 847 880 ± 244 333 ± 107 49 ± 13 18 ± 9
45	P	-	-	Pre-season Total distance (m) Distance >12.24 km·h⁻¹ (m) Distance > 19.44 km·h⁻¹ (NR) ACC >2 ms² (NR) DEC < −2 ms² (NR) Early-season Total distance (m) Distance >12.24 km·h⁻¹ (m) Distance > 19.44 km·h⁻¹ (NR)	6646 ± 111 1415 ± 42 27 ± 15 59 ± 19 22 ± 10 5437 ± 106 1027 ± 40 24 ± 9 49 ± 14

Table 4. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				ACC >2 ms^{-2} (NR) DEC < −2 ms^{-2} (NR) Late-season Total distance (m) Distance >12.24 km·h^{-1} (m) Distance > 19.44 km·h^{-1} (NR) ACC >2 ms^{-2} (NR) DEC < −2 ms^{-2} (NR)	20 ± 10 4604 ± 110 742 ± 41 15 ± 9 32 ± 18 12 ± 9
48	P	HR	Non-extractable data	TL-HR/GPS Total distance	Non-extractable data
64	P	Training period RPE (AU) s-RPE (CR-10, AU)	6 ± 1 482 ± 118	–	–
64	P	Mandatory confinement RPE (AU) s-RPE (CR-10, AU)	5 ± 0.1 489 ± 4	–	–
17	P	HR s-RPE (CR-10, AU)	Non-extractable data	–	–
66	A	s-RPE (CR-10, AU)	No injury = 440 ± 158 Injury = 517 ± 138	–	–
Range values	**-**	**s-RPE (CR-10, AU)** **RPE (CR-10, AU)** **Banister TRIMP (AU)**	**51–721** **1–7** **67–498**	**Total distance (m)** **Distance > 19.4 km·h^{-1} (m)**	**2347–6646** **9–543**

A: amateur; P: professional; HR: heart rate; TD: total distance; NR: number; NR.s: number per second; DC: distance covered; TL-HR/GPS: training intensity based on HR and GPS metrics; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; AU: arbitrary units; GPS: global positioning system.

Table 5. Results for internal and external match intensity.

Study	Level	Internal intensity	Overall team	External intensity	Overall team
[26]	P	International (full) matches		International (full) matches	
		HRavg (bpm)	162 ± 6	Total distance (m)	9900 ± 1800
		First half	164 ± 6	Distance ≥ 8 km·h^{-1} (m)	5900 ± 100
		HRavg (bpm)		Distance ≥ 15 km·h^{-1} (m)	1530 ± 100
		Second half	162 ± 7	Distance ≥ 25 km·h^{-1} (m)	256 ± 57
		HRavg (bpm)		First half	
		Domestic (full) matches	163 ± 5	Total distance (m)	5000 ± 900
		HRavg (bpm)		Distance ≥ 8 km·h^{-1} (m)	3000 ± 100
		First half	164 ± 6	Distance ≥ 15 km·h^{-1} (m)	820 ± 50
		HRavg (bpm)		Distance ≥ 25 km·h^{-1} (m)	136 ± 3
		Second half	159 ± 5	Second half	
		HRavg (bpm)		Total distance (m)	4900 ± 1000
				Distance ≥ 8 km·h^{-1} (m)	2900 ± 100
				Distance ≥ 15 km·h^{-1} (m)	720 ± 50
				Distance ≥ 25 km·h^{-1} (m)	120 ± 3
				Domestic (full) matches	
				Total distance (m)	9700 ± 1400
				Distance ≥ 8 km·h^{-1} (m)	5800 ± 100
				Distance ≥ 15 km·h^{-1} (m)	1330 ± 900
				Distance ≥ 25 km·h^{-1} (m)	221 ± 45
				First half	
				Total distance (m)	4900 ± 800
				Distance ≥ 8 km·h^{-1} (m)	2900 ± 100
				Distance ≥ 15 km·h^{-1} (m)	710 ± 50
				Distance ≥ 25 km·h^{-1} (m)	114 ± 2
				Second half	
				Total distance (m)	4800 ± 800
				Distance ≥ 8 km·h^{-1} (m)	2800 ± 100
				Distance ≥ 15 km·h^{-1} (m)	620 ± 40
				Distance ≥ 25 km·h^{-1} (m)	107 ± 2
[27]	A	Out of conference		Out of conference	
		TL-HR/GPS based metric	~247	Total Distance (m)	~8368.5
		(TL/min)	~34	Distance 15.0–19.9 km·h^{-1} (m)	~820.9
		80–89% HRmax (min)	~38	Distance ≥ 20 km·h^{-1} (m)	~255.0
		90–100% HRmax (min)		ACC ≥ 2.8 ms^{-2} (NR)	~15.9
[27]	A	In-conference		In-conference	
		TL-HR/GPS based metric	~270	Total distance (m)	~9277.7
		(TL/min)	~42	Distance 15.0–19.9 km·h^{-1} (m)	~899
		80–89% HRmax (min)	~34	Distance ≥ 20 km·h^{-1} (m)	~287.7
		90–100% HRmax (min)		ACC ≥ 2.8 ms^{-2} (NR)	~18.0
[35]	P	s-RPE (CR-10, AU)	893 ± 359	Total distance (m)	5480 ± 2350
				Distance 1.0–4.99 km·h^{-1} (m)	1740 ± 790
				Distance 5–9.99 km·h^{-1} (m)	1830 ± 920
				Distance 10–14.99 km·h^{-1} (m)	1320 ± 730
				Distance 15–19.99 km·h^{-1} (m)	460 ± 250
				Distance 20–24.99 km·h^{-1} (m)	110 ± 80
				Distance ≥25 km·h^{-1} (m)	20 ± 20
				Player Intensity (NR.s)	20120 ± 8609
[36]	P	–	–	Total distance (m)	8237 ± 507
				Distance 0–5.9 km·h^{-1} (m)	3214 ± 223
				Distance 6–11.9 km·h^{-1} (m)	3186 ± 291
				Distance 12–13.9 km·h^{-1} (m)	750 ± 72
				Distance 14–17.9 km·h^{-1} (m)	758 ± 67

(continued)

Table 5. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				Distance 18–23.9 km·h^{-1} (m)	307 ± 42
				Distance >24 km·h^{-1} (m)	22 ± 9
				ACC 1–1.9 ms^{-2} (m)	174 ± 17
				ACC 2–2.9 ms^{-2} (m)	41 ± 6
				ACC 3–4 ms^{-2} (m)	3 ± 0.4
				DEC 1–1.9 ms^{-2} (m)	146 ± 13
				DEC 2–2.9 ms^{-2} (m)	44 ± 7
				DEC 3–4 ms^{-2} (m)	15 ± 3
				Maximal speed (km·h^{-1})	24.5 ± 1
				Distance >24 km·h^{-1} (NR)	15 ± 5
37	P	–	–	Domestic	
				Total distance (m)	8728 ± 283
				Distance 16–20 km·h^{-1} (m)	609 ± 69
				Distance > 20 km·h^{-1} (m)	306 ± 56
37	P	–	–	International	
				Total distance (m)	9433 ± 263
				Distance 16–20 km·h^{-1} (m)	766 ± 64
				Distance > 20 km·h^{-1} (m)	364 ± 53
38	P	–	–	First half	
				Total distance (m)	4936 ± 78
				Distance 12–19 km·h^{-1} (m)	1244 ± 61
				Distance > 19 km·h^{-1} (m)	173 ± 15
				Second half	4695 ± 108
				Total distance (m)	1163 ± 71
				Distance 12–19 km·h^{-1} (m)	165 ± 18
				Distance > 19 km·h^{-1} (m)	
41	P	–	–	Total distance	Non-extractable data
				Distance < 13.20 ± 0.71 km·h^{-1} (m)	
				Distance 13.20–16.69 km·h^{-1} (m)	
				Distance 16.69–19.94 km·h^{-1} (m)	
				Distance > 19.94 ± 0.88 km·h^{-1} (m)	
				Distance 13.20–19.24 km·h^{-1} (NR)	
				Distance >19.94 km·h^{-1} (NR)	
42	A	–	–	Total distance (m)	3994–7449
				Distance 1.0–5.99 km·h^{-1} (m)	1924–691
				Distance 6.0–10.99 km·h^{-1} (m)	1913–720
				Distance 11.0–15.49 km·h^{-1} (m)	1253–520
				Distance 15.5–19.9 km·h^{-1} (m)	434–180
				Distance > 20 km·h^{-1} (m)	167–99
43	P	–	–	Distance 0 km·h^{-1} (m)	Non-extractable data
				Distance 6 km·h^{-1} (m)	
				Distance 8 km·h^{-1} (m)	
				Distance 12 km·h^{-1} (m)	
				Distance 15 km·h^{-1} (m)	
				Distance 18 km·h^{-1} (m)	
				Distance 25 km·h^{-1} (m)	
45	P	–	–	Friendly match	
				Total distance (m)	7972 ± 412
				Distance 12.2–19.1 km·h^{-1} (m)	1905 ± 185
				Sprint distance >19.4 km·h^{-1} (m)	301 ± 126

(continued)

Table 5. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				ACC > 2 ms^{-2} (NR)	49 ± 20
				DEC > −2 ms^{-2} (NR)	21 ± 9
[47]	P	s-RPE (CR-10)	Non-extractable data	–	–
[48]	P	HR	Non-extractable data	TL-HR/GPS based metric TD	Non-extractable data
[49]	P	–	–	International players	
				Total distance (m)	10033 ± 1500
				Distance > 18 km·h^{-1} (m)	1680 ± 90
				Distance > 25 km·h^{-1} (m)	460 ± 20
				Distance 18 km·h^{-1} (NR)	154 ± 7
				Distance 25 km·h^{-1} (NR)	30 ± 2
				National players	10044 ± 1500
				Total distance (m)	1300 ± 100
				Distance > 18 km·h^{-1} (m)	380 ± 50
				Distance > 25 km·h^{-1} (m)	125 ± 7
				Distance 18 km·h^{-1} (NR)	26 ± 1
				Distance 25 km·h^{-1} (NR)	5280 ± 90
				First half international players	910 ± 50
				Total distance (m)	250 ± 20
				Distance > 18 km·h^{-1} (m)	5050 ± 80
				Distance > 25 km·h^{-1} (m)	700 ± 40
				2nd half international players	210 ± 10
				Total distance (m)	5220 ± 90
				Distance > 18 km·h^{-1} (m)	680 ± 60
				Distance > 25 km·h^{-1} (m)	200 ± 30
				First half National players	5210 ± 80
				Total distance (m)	620 ± 40
				Distance > 18 km·h^{-1} (m)	170 ± 20
				Distance > 25 km·h^{-1} (m)	
				2nd half National players	
				Total distance (m)	
				Distance > 18 km·h^{-1} (m)	
				Distance > 25 km·h^{-1} (m)	
[52]	P	–	–	Distance <14.4 km·h^{-1} (m)	3516–3659
				Distance ≥14.4–19.8 km·h^{-1} (m)	419–449
				Distance ≥19.8–25.2 km·h^{-1} (m)	95–104
				Distance ≥25.1 km·h^{-1} (m)	1–20
[52]	P	–	–	Distance <12 km·h^{-1} (m)	3100–3226
				Distance ≥12–15.9 km·h^{-1} (m)	568–610
				Distance ≥16–19.9 km·h^{-1} (m)	244–266
				Distance ≥20 km·h^{-1} (m)	96–107
[58]	P	–	–	Distance ≥ 10.8 km·h^{-1}	Non-extractable data
				Distance ≥ 19 km·h^{-1}	
				Distance ≥ 22.5 km·h^{-1}	
[60]	A	Hrmax	Non-extractable data	First half	
				Total distance (m)	2898 ± 410
				Player intensity (AU)	319 ± 56
				Distance <11.88 km·h^{-1} (m)	2499 ± 326
				Distance 12.24–15.48 km·h^{-1} (m)	172 ± 109
				Distance >16.2 km·h^{-1} (m)	511 ± 606
				Second half	

(continued)

Table 5. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				Total distance (m)	2674 ± 546
				Player intensity (AU)	298 ± 74
				Distance <11.88 km·h^{-1} (m)	2310 ± 452
				Distance 12.24–15.48 km·h^{-1} (m)	161 ± 91
				Distance >16.2 km·h^{-1} (m)	361 ± 81
[63]	A	–	–	U15	
				Total distance	6961 ± 223
				Distance 0–6.0 km·h^{-1} (m)	2670 ± 100
				Distance 6.1–8.0 km·h^{-1} (m)	832 ± 55
				Distance 8.1–12.0 km·h^{-1} (m)	1974 ± 150
				Distance 12.1–15.5 km·h^{-1} (m)	944 ± 116
				Distance 15.6–20.0 km·h^{-1} (m)	458 ± 58
				Distance > 20.0 km·h^{-1} (m)	76 ± 35
				Distance > 20.0 km·h^{-1} (NR)	5 ± 2
				Maximal speed (km·h^{-1})	24.3 ± 0.5
				First half	3480 ± 129
				Total distance	1274 ± 47
				Distance 0–6.0 km·h^{-1} (m)	434 ± 29
				Distance 6.1–8.0 km·h^{-1} (m)	1022 ± 72
				Distance 8.1–12.0 km·h^{-1} (m)	478 ± 62
				Distance 12.1–15.5 km·h^{-1} (m)	224 ± 32
				Distance 15.6–20.0 km·h^{-1} (m)	44 ± 21
				Distance > 20.0 km·h^{-1} (m)	3 ± 1
				Distance > 20.0 km·h^{-1} (NR)	23.2 ± 0.6
				Maximal speed (km·h^{-1})	3478 ± 119
				Second half	1369 ± 56
				Total distance	397 ± 29
				Distance 0–6.0 km·h^{-1} (m)	952 ± 84
				Distance 6.1–8.0 km·h^{-1} (m)	465 ± 60
				Distance 8.1–12.0 km·h^{-1} (m)	234 ± 33
				Distance 12.1–15.5 km·h^{-1} (m)	31 ± 18
				Distance 15.6–20.0 km·h^{-1} (m)	2 ± 1
				Distance > 20.0 km·h^{-1} (m)	23.7 ± 0.6
				Distance > 20.0 km·h^{-1} (NR)	
				Maximal speed (km·h^{-1})	
[63]	A	–	–	U16	
				Total distance	8024 ± 101
				Distance 0–6.0 km·h^{-1} (m)	2838 ± 42
				Distance 6.1–8.0 km·h^{-1} (m)	946 ± 23
				Distance 8.1–12.0 km·h^{-1} (m)	2230 ± 64
				Distance 12.1–15.5 km·h^{-1} (m)	1209 ± 50
				Distance 15.6–20.0 km·h^{-1} (m)	611 ± 25
				Distance > 20.0 km·h^{-1} (m)	185 ± 15
				Distance > 20.0 km·h^{-1} (NR)	11 ± 1
				Maximal speed (km·h^{-1})	25.6 ± 0.2
				First half	4084 ± 56
				Total distance	1408 ± 20
				Distance 0–6.0 km·h^{-1} (m)	488 ± 12
				Distance 6.1–8.0 km·h^{-1} (m)	1147 ± 31
				Distance 8.1–12.0 km·h^{-1} (m)	628 ± 27
				Distance 12.1–15.5 km·h^{-1} (m)	314 ± 14
				Distance 15.6–20.0 km·h^{-1} (m)	95 ± 9
				Distance > 20.0 km·h^{-1} (m)	6 ± 1
				Distance > 20.0 km·h^{-1} (NR)	25.1 ± 0.2
				Maximal speed (km·h^{-1})	3941 ± 50

(continued)

Table 5. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				Second half	1430 ± 24
				Total distance	459 ± 12
				Distance 0–6.0 km·h^{-1} (m)	1083 ± 36
				Distance 6.1–8.0 km·h^{-1} (m)	580 ± 25
				Distance 8.1–12.0 km·h^{-1} (m)	296 ± 14
				Distance 12.1–15.5 km·h^{-1} (m)	89 ± 8
				Distance 15.6–20.0 km·h^{-1} (m)	5 ± 1
				Distance > 20.0 km·h^{-1} (m)	24.6 ± 0.2
				Distance > 20.0 km·h^{-1} (NR)	
				Maximal speed (km·h^{-1})	
63	A	–	–	U17	
				Total distance	8558 ± 223
				Distance 0–6.0 km·h^{-1} (m)	2549 ± 93
				Distance 6.1–8.0 km·h^{-1} (m)	175 ± 51
				Distance 8.1–12.0 km·h^{-1} (m)	2621 ± 141
				Distance 12.1–15.5 km·h^{-1} (m)	1413 ± 109
				Distance 15.6–20.0 km·h^{-1} (m)	658 ± 54
				Distance > 20.0 km·h^{-1} (m)	235 ± 33
				Distance > 20.0 km·h^{-1} (NR)	13 ± 2
				Maximal speed (km·h^{-1})	25.6 ± 0.5
				First half	4322 ± 125
				Total distance	1231 ± 46
				Distance 0–6.0 km·h^{-1} (m)	547 ± 28
				Distance 6.1–8.0 km·h^{-1} (m)	1316 ± 69
				Distance 8.1–12.0 km·h^{-1} (m)	746 ± 60
				Distance 12.1–15.5 km·h^{-1} (m)	345 ± 31
				Distance 15.6–20.0 km·h^{-1} (m)	134 ± 20
				Distance > 20.0 km·h^{-1} (m)	7 ± 1
				Distance > 20.0 km·h^{-1} (NR)	24.9 ± 0.6
				Maximal speed (km·h^{-1})	4236 ± 109
				Second half	1315 ± 52
				Total distance	527 ± 26
				Distance 0–6.0 km·h^{-1} (m)	1308 ± 77
				Distance 6.1–8.0 km·h^{-1} (m)	668 ± 55
				Distance 8.1–12.0 km·h^{-1} (m)	314 ± 30
				Distance 12.1–15.5 km·h^{-1} (m)	100 ± 17
				Distance 15.6–20.0 km·h^{-1} (m)	6 ± 1
				Distance > 20.0 km·h^{-1} (m)	25.5 ± 0.5
				Distance > 20.0 km·h^{-1} (NR)	
				Maximal speed (km·h^{-1})	
65	P	–	–	In-season full match	
				Duration (min)	73 ± 13
				Total distance (m)	7482 ± 959
				Distance 0–1.98 km·h^{-1} (m)	202 ± 26
				Distance 1.99–6.95 km·h^{-1} (m)	2885 ± 688
				Distance 6.96–8.96 km·h^{-1} (m)	1020 ± 173
				Distance 8.97–12.99 km·h^{-1} (m)	1963 ± 296
				Distance 13.0–15.95 km·h^{-1} (m)	770 ± 127
				Distance 15.96–21.9 km·h^{-1} (m)	557 ± 137
				Distance ≥ 22.0 km·h^{-1} (m)	86 ± 81
				Distance < 13 km·h^{-1} (m)	6069 ± 926
				Distance ≥ 13 km·h^{-1} (m)	1413 ± 245
				Exertion index (AU)	63 ± 9
				Player intensity (AU)	814 ± 164
				First half	38 ± 7

(continued)

Table 5. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				Duration (min)	3862 ± 560
				Total distance (m)	104 ± 11
				Distance 0–1.98 km·h^{-1} (m)	1465 ± 367
				Distance 1.99–6.95 km·h^{-1} (m)	535 ± 98
				Distance 6.96–8.96 km·h^{-1} (m)	1025 ± 156
				Distance 8.97–12.99 km·h^{-1} (m)	405 ± 73
				Distance 13.0–15.95 km·h^{-1} (m)	284 ± 78
				Distance 15.96–21.9 km·h^{-1} (m)	45 ± 46
				Distance $\geq$ 22.0 km·h^{-1} (m)	3129 ± 514
				Distance < 13 km·h^{-1} (m)	733 ± 145
				Distance $\geq$ 13 km·h^{-1} (m)	33 ± 5
				Exertion index (AU)	423 ± 87
				Player intensity (AU)	35 ± 6
				Second half	3620 ± 454
				Duration (min)	98 ± 17
				Total distance (m)	1419 ± 331
				Distance 0–1.98 km·h^{-1} (m)	484 ± 80
				Distance 1.99–6.95 km·h^{-1} (m)	938 ± 158
				Distance 6.96–8.96 km·h^{-1} (m)	365 ± 60
				Distance 8.97–12.99 km·h^{-1} (m)	273 ± 63
				Distance 13.0–15.95 km·h^{-1} (m)	42 ± 35
				Distance 15.96–21.9 km·h^{-1} (m)	2940 ± 448
				Distance $\geq$ 22.0 km·h^{-1} (m)	680 ± 111
				Distance < 13 km·h^{-1} (m)	30 ± 4
				Distance $\geq$ 13 km·h^{-1} (m)	392 ± 81
				Exertion index (AU)	
				Player intensity (AU)	
65	P	–	–	Post-season full match	
				Duration (min)	85 ± 10
				Total distance (m)	8201 ± 693
				Distance 0–1.98 km·h^{-1} (m)	262 ± 100
				Distance 1.99–6.95 km·h^{-1} (m)	3295 ± 372
				Distance 6.96–8.96 km·h^{-1} (m)	1116 ± 225
				Distance 8.97–12.99 km·h^{-1} (m)	237 ± 383
				Distance 13.0–15.95 km·h^{-1} (m)	802 ± 144
				Distance 15.96–21.9 km·h^{-1} (m)	603 ± 139
				Distance $\geq$ 22.0 km·h^{-1} (m)	85 ± 81
				Distance < 13 km·h^{-1} (m)	6710 ± 579
				Distance $\geq$ 13 km·h^{-1} (m)	1491 ± 220
				Exertion index (AU)	66 ± 9
				Player intensity (AU)	911 ± 248
				First half	44 ± 4
				Duration (min)	4337 ± 397
				Total distance (m)	131 ± 35
				Distance 0–1.98 km·h^{-1} (m)	1718 ± 191
				Distance 1.99–6.95 km·h^{-1} (m)	602 ± 113
				Distance 6.96–8.96 km·h^{-1} (m)	183 ± 196
				Distance 8.97–12.99 km·h^{-1} (m)	426 ± 91
				Distance 13.0–15.95 km·h^{-1} (m)	325 ± 85
				Distance 15.96–21.9 km·h^{-1} (m)	51 ± 52
				Distance $\geq$ 22.0 km·h^{-1} (m)	3534 ± 332
				Distance < 13 km·h^{-1} (m)	803 ± 133
				Distance $\geq$ 13 km·h^{-1} (m)	36 ± 5
				Exertion index (AU)	488 ± 139
				Player intensity (AU)	41 ± 8

(continued)

Table 5. (continued)

Study	Level	Internal intensity	Overall team	External intensity	Overall team
				Second half	3864 ± 418
				Duration (min)	130 ± 67
				Total distance (m)	1577 ± 215
				Distance 0–1.98 km·h^{-1} (m)	515 ± 131
				Distance 1.99–6.95 km·h^{-1} (m)	955 ± 211
				Distance 6.96–8.96 km·h^{-1} (m)	376 ± 68
				Distance 8.97–12.99 km·h^{-1} (m)	278 ± 62
				Distance 13.0–15.95 km·h^{-1} (m)	34 ± 33
				Distance 15.96–21.9 km·h^{-1} (m)	3176 ± 354
				Distance $\geq$ 22.0 km·h^{-1} (m)	688 ± 104
				Distance < 13 km·h^{-1} (m)	31 ± 5
				Distance $\geq$ 13 km·h^{-1} (m)	424 ± 115
				Exertion index (AU)	
				Player intensity (AU)	
67	P	Regular (90 min)		Regular (90 min)	
		Hravg (bpm)	165 ± 2	TD (m)	9540 ± 178
		Hrexertion (AU/min)	503 ± 27	HMLD (m)	1839 ± 83
				Speed exertion (AU/min)	7507 ± 349
67	P	Extra time (90–110 min)		Extra time (90–110 min)	
		HRavg (HR)	163 ± 3	TD (m)	2159 ± 55
		HRexertion (AU/min)	102 ± 7	HMLD (m)	440 ± 26
				Speed exertion (AU/min)	1753 ± 84
Range values	**–**	**s-RPE (CR-10, AU)**	**240–893**	**Professional total distance (m)**	**5480–10581**
		HRavg (bpm)	**162–173**	**Amateur total distance (m)**	**3994–8558**
		HRmax (bpm)	**181–194**	**Distance $\geq$ 14 km h^{-1}**	**543–2520**
				Distance $\geq$ 18 km h^{-1}	**96–1680**
				ACC > 2 ms^{-2} (NR)	**49–240**
				DEC > 2 ms^{-2} (NR)	**21–85**
				Player intensity (AU)	**848–1096**

A: amateur; P: professional; HR: heart rate; TD: total distance; NR: number; DC: distance covered; TL-HR/GPS: training intensity based on HR and GPS metrics; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; GPS: global positioning system; HRavg: average heart rate; bpm: beats per minute; HSR: high-speed running; VHSR: very high-speed running; ACC: acceleration; DEC: deceleration; HMLD: high metabolic intensity distance; m/min: meters per minute.

values reported by Doyle et al.[16] study (mean 4 and range of 1–7 AU). Moreover, in a Chile women's national soccer team, they ranged from 6 ± 1 and 5 ± 0.1 (no range intervals were provided) during normal training and confinement training, respectively.[64] Possible differences could be attributed to the different training days number (3 days[29] vs. 5 days[64] vs. 7 days[16]).

Furthermore, HR measures can serve as objective markers of internal intensity and can enable practitioners to design training sessions that meet the demands of the game and provide appropriate aerobic stimuli.[74,75] Measuring an individual athlete's HR can allow professionals to consider the principle of individuality in intensity monitoring.[76]

However, there are some significant limitations to using HR for quantifying internal intensity, including the need for knowledge of technical proficiency and expertise in interpreting the results. HR is also a poor variable for measuring high-intensity activities such as resistance, speed and power-based training modalities.[76] For these reasons, HR is reliable for continuous efforts performed at intensities below the anaerobic threshold and without significant intensity variations.[76] This is probably why HR measures were not especially common in the studies included in the present systematic review, especially when absolute values were considered.

Meanwhile, different training impulse (TRIMP) methods for monitoring intensity based on HR have been suggested.[77,78] A method proposed to facilitate calculating internal intensity is to use HR intensity across a session and multiply the obtained value by the session duration. This method provides a quantitative internal training- or match-

Table 6. Results for external training intensity, internal and external match intensity by players positions.

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
53	P	Total distance km·h⁻¹ (m)	~2347–3047	~3047	~2704	~2885	~2347	~2616	–
		Distance 0–6 km·h⁻¹ (m)	~193–1232	~1232	~1007	~1208	~1134	~193	
		Distance (6–8 km·h⁻¹ (m)	~162–320	~320	~282	~278	~162	~236	
		Distance (8–12 km·h⁻¹ (m)	~426–750	~750	~630	~653	~426	~588	
		Distance (12–15 km·h⁻¹ (m)	~264–398	~398	~333	~357	~264	~324	
		Distance 15–20 km·h⁻¹ (m)	~204–264	~236	~208	~264	~204	~250	
		Distance > 20 km·h⁻¹ (m)	~116–162	~144	~116	~125	~162	~116	
		DEC (NR)	~1.9–3.7	~2.8	~1.9	~3.7	~1.9	~3.7	
		ACC (NR)	~0.9–4.1	~4.1	~3.7	~3.2	~0.9	~3.2	

Internal match intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Flank players	Forwards	Goalkeepers
40	P	s-RPE (CR-10)	240±79	226±60	–	279±69	240±79	185±46	145±66
		HRAvg (bpm)	142±20	144±23		147±10	144±21	133±8	121±29

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielder	Wide midfielders	Forwards	Goalkeepers
51	P	**Full-match**							
		HRavg (bpm)	169–173	169±9	171±11	170±10	173±8	170±8	148±10
		HRmax (bpm)	181–194	192±8	190±9	190±11	193±13	194±6	181±11
51	P	**First half**							
		HRavg (bpm)	170–174	170±9	172±11	172±10	174±9	171±9	–
		HRmax (bpm)	190–193	88±4	190±9	190±11	193±13	193±6	
51	P	**Second half**							
		HRavg (bpm)	167–171	167±9	170±11	168±11	171±8	169±7	–
		HRmax (bpm)	187–191	190±9	187±10	189±11	191±13	190±6	

External match intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Flank Players	Forwards	Goalkeepers
40	P	Total distance (m)	9793±2715	9956±2511	–	10575±511	10056±2763	7831±2180	5622±1953
		Distance >19.00 km·h⁻¹ (NR)	15±8	16±7		17±8	18±7	11±5	5±3
		Acc ±0.5–1.99 ms⁻² (NR)	953±260	996±232		991±250	919±264	763±183	900±323
		Acc ±2.00–2.99 ms⁻² (NR)	64±23	66±19		70±22	69±21	51±14	27±11
		Acc ±3.00–5.00 ms⁻² (NR)	10±6	10±5		11±6	12±5	7±4	3±3
		Dec ±0.5–1.99 ms⁻² (NR)	1010±266	1057±236		1038±252	970±274	820±190	1006±343
		Dec ±2.00–2.99 ms⁻² (NR)	695±27	729±19		77±24	74±24	55±15	23±10
		Dec ±3.00–5.00 ms⁻² (NR)	17±8	14±6		12±6	17±8	10±5	4±3
		Distance <6.99 km·h⁻¹ (m)	4299±1182	4673±1242		4138±831	4310±1261	3176±786	4537±1565
		Distance 7.0–14.99 km·h⁻¹ (m)	4358±1744	4207±1202		5420±1349	4471±1342	3857±1289	1055±490

(continued)

Table 6. (continued)

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
		Distance 15.0–18.99 km·h^{-1} (m)	739 ± 389	685 ± 306		916 ± 276	836 ± 371	658 ± 253	42 ± 24
		Distance >19.00 km·h^{-1} (m)	282 ± 205	309 ± 163		266 ± 117	403 ± 258	140 ± 65	7 ± 15
		Distance > 15 km·h^{-1} (m)	1019 ± 560	1004 ± 417		1145 ± 388	1264 ± 613	798 ± 308	48 ± 31
Study 28	P	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide forwards	Forwards	Goalkeepers
		First half							–
		Distance 0–12 km·h^{-1} (m)	3836 ± 17	3822 ± 19	3791 ± 43	3921 ± 25	3830 ± 51	3737 ± 53	
		Distance 12–15 km·h^{-1} (m)	797 ± 22	752 ± 31	780 ± 48	900 ± 43	779 ± 65	679 ± 43	
		Distance 15–18 km·h^{-1} (m)	457 ± 17	363 ± 25	467 ± 45	506 ± 24	525 ± 57	441 ± 31	
		Distance 18–21 km·h^{-1} (m)	248 ± 10	189 ± 13	249 ± 26	266 ± 16	280 ± 24	301 ± 22	
		Distance 21–23 km·h^{-1} (m)	78 ± 5	48 ± 7	83 ± 14	82 ± 8	100 ± 19	105 ± 13	
		Distance 23–25 km·h^{-1} (m)	38 ± 4	31 ± 6	40 ± 10	33 ± 6	38 ± 9	67 ± 10	
		Distance 25–27 km·h^{-1} (m)	20 ± 3	12 ± 5	23 ± 6	10 ± 3	31 ± 10	47 ± 17	
		Distance > 27 km·h^{-1} (m)	12 ± 2	13 ± 5	3 ± 2	6 ± 2	12 ± 7	46 ± 10	
		2st half							
		Distance 0–12 km·h^{-1} (m)	3767 ± 27	3700 ± 54	3743 ± 68	3834 ± 41	3797 ± 92	3746 ± 64	
		Distance 12–15 km·h^{-1} (m)	705 ± 21	632 ± 34	732 ± 50	780 ± 45	647 ± 42	697 ± 41	
		Distance 15–18 km·h^{-1} (m)	415 ± 17	367 ± 32	436 ± 45	438 ± 34	420 ± 36	415 ± 27	
		Distance 18–21 km·h^{-1} (m)	238 ± 11	197 ± 18	244 ± 29	246 ± 22	282 ± 21	244 ± 29	
		Distance 21–23 km·h^{-1} (m)	75 ± 5	66 ± 12	66 ± 12	73 ± 9	91 ± 11	107 ± 19	
		Distance 23–25 km·h^{-1} (m)	40 ± 5	32 ± 8	33 ± 7	37 ± 9	47 ± 11	71 ± 22	
		Distance 25–27 km·h^{-1} (m)	19 ± 3	9 ± 3	10 ± 4	21 ± 6	31 ± 7	41 ± 11	
		Distance >27 km·h^{-1} (m)	8 ± 2	4 ± 2	5 ± 2	5 ± 3	19 ± 8	23 ± 14	
		Full match							
		Distance 0–12 km·h^{-1} (m)	7603 ± 38	7522 ± 62	7534 ± 92	7758 ± 55	7627 ± 131	7483 ± 93	
		Distance 12–15 km·h^{-1} (m)	1502 ± 38	1384 ± 56	1513 ± 81	1680 ± 81	1425 ± 93	1376 ± 73	
		Distance 15–18 km·h^{-1} (m)	872 ± 31	730 ± 48	903 ± 81	944 ± 52	945 ± 90	856 ± 55	
		Distance 18–21 km·h^{-1} (m)	486 ± 19	386 ± 27	494 ± 51	512 ± 35	563 ± 36	545 ± 38	
		Distance 21–23 km·h^{-1} (m)	154 ± 9	115 ± 13	149 ± 21	155 ± 12	190 ± 26	211 ± 30	
		Distance 23–25 km·h^{-1} (m)	78 ± 6	63 ± 8	73 ± 14	69 ± 9	86 ± 14	138 ± 31	
		Distance 25–27 km·h^{-1} (m)	39 ± 5	21 ± 6	33 ± 8	31 ± 7	62 ± 16	88 ± 25	
		Distance >27 km·h^{-1} (m)	20 ± 4	17 ± 6	7 ± 3	11 ± 3	31 ± 11	69 ± 14	
30	P	Total distance (m)	10321 ± 859	9489 ± 562	10250 ± 661	10985 ± 76	10623 ± 665	10262 ± 798	–
		Distance 0.7–7.1 km·h^{-1} (m)	3326 ± 194	3401 ± 142	3301 ± 190	3224 ± 183	3328 ± 182	3449 ± 214	
		Distance 7.2–14.3 km·h^{-1} (m)	4448 ± 537	4158 ± 457	4382 ± 426	4857 ± 451	4488 ± 445	4202 ± 606	
		Distance 14.4–19.7 km·h^{-1} (m)	1744 ± 373	1367 ± 193	1743 ± 293	2029 ± 310	1865 ± 324	1714 ± 338	
		Distance 19.8–25.1 km·h^{-1} (m)	608 ± 181	423 ± 79	634 ± 168	683 ± 170	700 ± 167	651 ± 135	
		Distance >25.1 km·h^{-1} (m)	168 ± 82	111 ± 42	163 ± 79	170 ± 69	220 ± 116	221 ± 53	
		Distance >14.4 km·h^{-1} (m)	2520 ± 580	1901 ± 268	2540 ± 500	2882 ± 500	2785 ± 510	2586 ± 463	
		Distance >19.8 km·h^{-1} (m)	776 ± 247	534 ± 113	796 ± 237	853 ± 229	920 ± 260	872 ± 161	

Table 6. (continued)

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
31	P	Distance 19.8–25.1 km·h⁻¹ (m)	169±49	119±22	170±45	190±46	197±46	189±36	–
		Distance >25.1 km·h⁻¹ (m)	33±13	22±7	32±14	35±12	40±14	42±8	—
46	P	Total distance (m)	10,025±775	9220±590	10,203±568	10,581±221	10,472±878	9661±602	–
		Distance 12.2–19.1 km·h⁻¹ (m)	2452±636	1772±439	2569±612	2761±417	2917±545	2420±405	—
		Distance >19.4 km·h⁻¹ (m)	615±258	417±116	680±278	484±169	850±178	841±238	—
51	P	Full-match							
		Total distance (m)	9274–10,572	9274±762	10,053±639	10,572±880	10519±963	9745±988	5214±949
		Distance >25 km·h⁻¹ (m)	1088–1786	1088±261	1529±369	1518±499	1786±527	1561±372	99±70
		Distance >15 km·h⁻¹ (m)	442–863	442±135	717±242	623±252	863±299	737±223	31±31
		Distance >18 km·h⁻¹ (m)	19–91	19±17	46±48	33±31	91±81	56±45	1±3
		Maximal speed (km·h⁻¹)	27.5–29.2	27.5±2	28±3	27.8±2	27.6±2.1	29.2±3	21.5±1
		ACC (NR)	864–945	864±114	878±136	945±140	871±116	884±126	695±164
		DEC (NR)	887–946	887±101	895±137	946±135	893±123	921±148	738±139
51	P	First half							
		Total distance (m)	4463–5283	4663±400	5031±405	5283±481	5283±481	4906±560	–
		Distance >25 km·h⁻¹ (m)	560–926	560±133	768±201	804±252	926±242	813±173	
		Distance >15 km·h⁻¹ (m)	232–459	232±56	367±131	328±129	459±158	383±95	
		Distance >18 km·h⁻¹ (m)	10–53	10±11	26±25	17±14	53±52	28±23	
		Maximal speed (km·h⁻¹)	25.9–27.5	25.9±2	27.0±2	26.3±1.7	27.0±2	27.5±2	
		ACC (NR)	432–487	441±61	432±70	487±71	442±71	462±95	
		DEC (NR)	452–486	452±55	454±75	486±73	456±66	480±104	
51	P	Second half							
		Total distance (m)	4611–5236	4611±394	5022±286	5193±544	5236±524	4839±483	–
		Distance >25 km·h⁻¹ (m)	528–863	528±144	761±195	714±261	863±304	748±221	
		Distance >15 km·h⁻¹ (m)	210–404	210±87	350±121	295±134	404±169	354±136	
		Distance >18 km·h⁻¹ (m)	9–39	9±9	19±26	16±20	39±39	28±24	
		Maximal speed (km·h⁻¹)	25.5–27.4	25.5±1.7	26.4±1.5	25.8±1.9	26.4±1.9	27.4±2	
		ACC (NR)	422–458	423±57	432±70	458±73	428±48	422±40	
		DEC (NR)	435–460	435±50	440±68	460±68	437±61	441±56	
53	P	Total distance (m)	~9472–10,313	~10,229	~10,313	~10,313	~10,173	~9472	–
		Distance 0–6 km·h⁻¹ (m)	~3862–4273	~4217	~4039	~4273	~3862	~3955	
		Distance 6–8 km·h⁻¹ (m)	~963–1225	~1225	~1094	~1178	~963	~1010	
		Distance 8–12 km·h⁻¹ (m)	~2235–2665	~2665	~2310	~2562	~2263	~2235	
		Distance 12–15 km·h⁻¹ (m)	~1197–1403	~1281	~1225	~1356	~1403	~1197	
		Distance 15–20 km·h⁻¹ (m)	~598–814	~598	~814	~692	~804	~720	
		Distance >20 km·h⁻¹ (m)	~206–411	~206	~411	~253	~393	~318	

Table 6. (continued)

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
		DEC (NR)	~7.5–15	~7.5	~13.1	~8.4	~13.1	~15	—
		ACC (NR)	~3.7–5.6	~5.6	~5.6	~3.7	~3.7	~5.6	—
59	P	International matches							
		Total distance (m)	9110–10,808	9110–9686	9637–10,147	9860–10,931	9942–10,808	9500–9976	4370–5117
		Distance ≥ 12.5 km·h⁻¹ (m)	1770–2958	1770–2168	2344–2696	2011–2947	2361–2958	2147–2476	0–480
		Distance ≥ 19.0 km·h⁻¹ (m)	277–773	277–422	528–651	292–559	559–773	506–622	0–385
		Distance ≥ 22.5 km·h⁻¹ (m)	70–291	70–127	166–218	45–119	204–291	185–232	0–40
		Maximal speed (km·h⁻¹)	28.0–31.6	28.8–30.3	29.5–30.6	28.0–30.5	29.5–31.6	29.8–30.8	27.0–28.9
59	P	Domestic matches							
		Total distance (m)	9203–10,905	9203–9613	9876–10,276	9924–10,905	10,060–10,616	9679–10,056	4148–4742
		Distance ≥12.5 km·h⁻¹ (m)	1795–2846	1795–2078	2092–2568	2124–2846	2459–2843	2292–2553	0–111
		Distance ≥19.0 km·h⁻¹ (m)	236–631	331–433	463–561	236–446	472–610	539–631	0–85
		Distance ≥22.5 km·h⁻¹ (m)	26–206	75–116	134–174	26–91	124–180	168–206	0–31
		Maximal Speed (km·h⁻¹)	28.1–30.7	29.1–30.2	29.3–30.3	28.1–29.9	29.1–30.7	29.6–30.5	25–26.6
Study	Level	Measures	Overall team	Defenders	Fullbacks	Midfielders		Forwards	
26	P	International matches							
		Total distance (m)	9500–10,600	9500±900	—	10,600±300		9800±200	—
		Distance ≥ 8 km·h⁻¹ (m)	5200–6900	5500±200		6900±500		5200±200	
		Distance ≥ 25 km·h⁻¹ (m)	221–316	221±32		316±51		262±46	
26	P	Domestic matches							
		Total distance (m)	9500–10,100	9500±100	—	10,100±300		9500±500	—
		Distance ≥ 8 km·h⁻¹ (m)	5100–6300	5700±300		6300±500		5100±400	
		Distance ≥ 25 km·h⁻¹ (m)	191–230	230±33		221±39		191±42	
32	P	Total distance	8883±1877	7871±1411	9303±1594	9144±1911		9005±2062	—
		Distance >17.8 km·h⁻¹ (m)	570±407	338±238	581±396	483±348		805±438	
		NR Distance >17.8 km·h⁻¹ (m)	40±23	27±17	41±21	37±23		52±22	
		NR Distance >22.7 km·h⁻¹ (m)	9±11	5±8	9±10	5±8		15±14	
		Player intensity (AU)	848±192	769±155	8773±161	884±190		845±20	
32	P	Draw 0-0							
		Total distance	8446–9978	8446±885	9978±1262	9877±1771		9108±2402	—
		Distance >17.8 km·h⁻¹ (m)	377–814	377±225	662±330	519±334		814±421	
		NR Distance >17.8 km·h⁻¹ (m)	29–57	29±12	45±16	43±24		57±53	
		NR Distance >22.7 km·h⁻¹ (m)	5–16	5±6	11±9	5±7		16±11	
		Player intensity (AU)	820–969	820±137	948±126	969±1956		878±251	

(continued)

Table 6. (continued)

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
32	P	Leading							
		Total distance (m)	7621–9117	7621 ± 1778	9117 ± 2007	8850 ± 2000	–	8914 ± 2200	–
		Distance >17.8 km·h⁻¹ (m)	267–804	267 ± 267	529 ± 510	471 ± 398	–	804 ± 484	
		NR Distance >17.8 km·h⁻¹ (m)	24–49	24 ± 22	36 ± 26	35 ± 25	–	49 ± 24	
		NR Distance >22.7 km·h⁻¹ (m)	5–16	5 ± 11	8 ± 12	6 ± 9	–	16 ± 17	
		Player intensity (AU)	743–855	743 ± 168	839 ± 191	855 ± 200	–	823 ± 234	
32	P	Trailing							
		Total distance (m)	7610–9076	7610 ± 1190	9076 ± 1004	8835 ± 1981	–	8839 ± 1550	–
		Distance >17.8 km·h⁻¹ (m)	412–797	412 ± 195	641 ± 207	477 ± 303	–	797 ± 393	
		NR Distance >17.8 km·h⁻¹ (m)	29–52	29 ± 11	46 ± 14	35 ± 18	–	52 ± 16	
		NR Distance >22.7 km·h⁻¹ (m)	5–13	7 ± 67	10 ± 6	5 ± 6	–	13 ± 10	
		Player intensity (AU)	743–873	743 ± 151	873 ± 121	834 ± 165	–	833 ± 175	
32	P	Draw not 0–0							
		Total distance (m)	8043–9634	8043 ± 659	8798 ± 809	9131 ± 1048	–	9634 ± 1327	–
		Distance >17.8 km·h⁻¹ (m)	350–798	350 ± 154	401 ± 226	452 ± 292	–	798 ± 464	
		NR Distance >17.8 km·h⁻¹ (m)	32–51	33 ± 13	32 ± 18	35 ± 15	–	51 ± 15	
		NR Distance >22.7 km·h⁻¹ (m)	4–16	4 ± 4	5 ± 5	6 ± 6	–	16 ± 18	
		Player intensity (AU)	814–906	814 ± 109	816 ± 110	906 ± 105	–	869 ± 133	
38	P	Total distance (m)	9631 ± 175	8759 ± 284	–	10,150 ± 227	–	9442 ± 356	–
		Distance 12–19 km·h⁻¹ (m)	2407 ± 125	1744 ± 138		2797 ± 174		2272 ± 205	
		Distance > 19 km·h⁻¹ (m)	338 ± 30	188 ± 31		392 ± 46		388 ± 56	
50	P	Distance > 20 km·h⁻¹ (NR)	18 ± 9	8 ± 3	21 ± 5	22 ± 10	–	23 ± 8	–
		Distance > 20 km·h⁻¹ (m)	285 ± 164	125 ± 61	359 ± 8	359 ± 174		352 ± 145	
54	P	Total distance (m)	8017 ± 1951	8207 ± 2140	–	8243 ± 1448	–	7602 ± 2267	–
		Distance ≤ 12 km·h⁻¹ (m)	2784 ± 947	3008 ± 827		3162 ± 1062		2183 ± 955	
		Distance 12 to 15.9 km·h⁻¹ (m)	1384 ± 539	1430 ± 474		1508 ± 656		1214 ± 486	
		Distance 16 to 19.9 km·h⁻¹ (m)	610 ± 250	607 ± 218		654 ± 287		567 ± 244	
		Distance ≥ 19.9 km·h⁻¹ (m)	308 ± 177	302 ± 159		277 ± 152		345 ± 219	
		ACC ≥ 2.00 ms⁻² (NR)	240 ± 79	252 ± 75		250 ± 89		220 ± 74	
		ACC 1.0–1.99 ms⁻² (NR)	75 ± 28	77 ± 25		77 ± 30		72 ± 28	
		DEC ≤ −2.00 ms⁻² (NR)	79 ± 29	82 ± 28		81 ± 31		75 ± 29	
		DEC −1.0–1.99 ms⁻² (NR)	242 ± 81	255 ± 78		248 ± 90		222 ± 76	
55	P	Distance 15.6–20 km·h⁻¹ (m)	509–859	509 ± 76	859 ± 99	552 ± 113	–	830 ± 191	–
		Distance > 20 km·h⁻¹ (m)	113–331	113 ± 44	331 ± 94	126 ± 48		323 ± 111	
		Total distance (m)	8202–9073	8202 ± 514	9073 ± 475	8486 ± 703		9056 ± 460	
		ACC > 2 ms⁻² (NR)	11–25	14 ± 3	19 ± 7	11 ± 4		25 ± 9	

Table 6. (continued)

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
		$DEC > -2$ ms^{-2} (NR)	13–17	13±3	15±6	14±5	–	17±6	–
		Player intensity (AU)	866–988	866±132	988±61	931±131		952±79	
56	P	Sénior							
		Total distance (m)	9825–10377	10,003±954	10,238±665	10,377±981	–	9825±894	–
		Distance 15.6–20 km·h^{-1} (m)	590–840	590±104	840±137	811±207		783±251	
		Distance >20 km·h^{-1} (m)	199–379	199±91	379±120	299±142		352±125	
		ACC >1 ms^{-2} (NR)	210–218	218±22	214±35	214±17		210±29	
		DEC >–1 ms^{-2} (NR)	161–182	161±19	182±23	178±19		176±27	
		Player intensity (AU)	133–1012	892±94	133±93	1012±99		894±145	
56	A	U20							
		Total distance (m)	8202–9073	8202±514	9073±475	8486±703	–	9056±460	–
		Distance 15.6–20 km·h^{-1}	509–859	509±76	859±99	552±113		830±191	
		Distance >20 km·h^{-1}	103–331	103±44	331±94	126±48		323±111	
		ACC >1 ms^{-2} (NR)	172–197	172±10	197±19	172±19		193±30	
		DEC >–1 ms^{-2} (NR)	108–146	108±14	138±21	111±17		146±25	
		Player intensity (AU)	866–988	866±132	988±61	931±131		952±79	
56	A	U17							
		Total distance (m)	7899–8575	7899±888	8575±996	8546±1260	–	8062±1407	–
		Distance 15.6–20 km·h^{-1} (m)	345–637	345±61	637±226	434±117		520±243	
		Distance >20 km·h^{-1} (m)	96–283	139±85	283±143	96±46		248±143	
		ACC >1 ms^{-2} (NR)	150–199	165±22	199±32	150±17		168±35	
		DEC >–1 ms^{-2} (NR)	86–122	86±15	122±16	93±14		106±27	
		Player intensity (AU)	692–889	744±66	781±48	889±62		692±121	
57	A	Total distance (m)	9486±300	8527–9551	–	8998–10034	–	9414–10349	–
		Distance >15 km·h^{-1} (m)	1014±118	665–1071		626–1054		1147–1519	
		Distance >18 km·h^{-1} (m)	428±70	265–504		141–393		524–743	
60	A	Total distance (m)	5567–6065	5567±818	–	6065±880	–	5847±739	–
		Player intensity (AU)	581–679	602±112		679±133		581±63	
		Distance <11.88 km·h^{-1} (m)	4669–5054	4669±560		5054±700		4823±651	
		Distance 12.24–15.48 km·h^{-1} (m)	329–343	329±196		329±217		343±133	
		Distance >16.2 km·h^{-1} (m)	679–931	931±1113		896±1197		679±714	

(continued)

Table 6. (continued)

External training intensity

Study	Level	Measures	Overall team	Central defenders	Fullbacks	Central midfielders	Wide midfielders	Forwards	Goalkeepers
61	P	Total distance (m)	10,368±952	9533±650	10,496±822	10,962±750	–	10,380±893	–
		Distance >19.98 km·h⁻¹ (m)	930±348	661±221	1191±314	973±334		1037±305	
		ACC NR	174±33	187±33	185±27	158±33		174±27	
		Distance >19.98 km·h⁻¹ (NR)	62±20	44±14	74±16	67±19		67±17	
		Distance >16.48 km·h⁻¹ (NR)	20±9	14±6	26±9	20±9		25±9	
		Player intensity (AU)	1096±239	982±159	1007±147	1265±237		1016±226	
62	P	Distance >25 km·h⁻¹ (m)	15±9	15±9	–	14±9	–	16±10	–
63	A	U15–U16–U17			–		–		–
		Total distance (m)	7779–8449	7779±114		8449±170		7952±299	
		Distance 0–6.0 km·h⁻¹ (m)	2764–2806	2764±47		2766±70		2806±123	
		Distance 6.1–8.0 km·h⁻¹ (m)	907–1004	938±25		1004±38		907±67	
		Distance 8.1–12.0 km·h⁻¹ (m)	2151–2258	2151±66		2253±99		2158±175	
		Distance 12.1–15.5 km·h⁻¹ (m)	1135–1389	1142±52		1389±78		1135±138	
		Distance 15.6–20.0 km·h⁻¹ (m)	590–665	590±27		600±40		665±71	
		Distance > 20.0 km·h⁻¹ (m)	131–275	188±16		131±24		275±42	
		Distance > 20.0 km·h⁻¹ (NR)	8–15	11±1		8±1		15±2	
		Maximal speed (km·h⁻¹)	24.7–26.7	25.6±0.2		24.7±0.4		26.7±0.6	

A: amateur; P: professional; HR: heart rate; NR: number; NR.s: number per second; TL-HR/GPS: training intensity based on HR and GPS metrics; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; GPS: global positioning system; HRAvg: average heart rate; bpm: beats per minute; HSR: high-speed running; ACC: acceleration; DEC: deceleration; Draw 0-0: match with no score; Leading: match with a winning result; Trailing: running behind other team; Draw but not 0–0: match with a result of 1-1 or 2-2 etc.

based measure of physiological intensity.[12] TRIMP measures were used in two studies included in the present systematic review.[29,33] They used Banister TRIMP to control internal intensity, reporting overall team values of 212 ± 81 (67–498) and 185 ± 43 AU. These values are lower than those reported by Brown et al.,[79] who reported values of 918 ± 325 AU (a total of 750 min/week) concerning a short (2 weeks) and very high-volume training period (increased by 39%). Despite its relevancy, the limited number of studies obtained in the presented systematic review makes us suggest that more studies should analyse TRIMP to confirm previous results.

When measuring external intensity, it is essential to determine the speed and accelerometry thresholds using absolute and individualised methods.[26,52] Absolute thresholds are easy to use, and they enable practitioners to compare physical characteristics between players in different positions. Considering that external intensity is related with several objective measures of training/competition (e.g. running distances, ACC and DEC), their quantification allows a better organisation of training plan prescription as well as a better training volume.[80]

External intensity data from five studies were obtained primarily by total distance,[16,35,44,45,53] and secondarily by distances covered at speeds higher than 19.4 km·h^{-1}.[16,35,44,45,53] These studies indicate a range value of 2347–6581 m in total distance during the in-season and ~6646 m during the pre-season.

Nevertheless, total distance does not reflect the different intensities that occur during training sessions. Thus, the use of generic speed thresholds facilitates player monitoring. However, it might not reflect the true energetic demands of the athlete, potentially leading to the misinterpretation of external demands.[81] A possible solution to this problem is to apply individualised thresholds to quantify running distances.[82] The individualisation of speed thresholds can be expressed in relation to maximum aerobic speed or maximum sprint speed.[83] Practitioners can then use these thresholds to determine individualised values, which reflect both high- and very-high-intensity exercise modalities. Meanwhile, there is little evidence to suggest that using individual thresholds is better than using generic thresholds when monitoring elite female soccer players.[84] For instance, none of the studies included in the present systematic review analysed individual speed thresholds for intensity, which makes it mandatory to conduct more studies with such individuality.

Thereafter, for some teams, that kind of task is almost impossible to put into practice; thus, we recommend using general speed thresholds, which are better than nothing. In that sense, other measures, including distances covered at speeds higher than 19.4 km·h^{-1}, showed a range interval of 9–543 m.[16,44,45,53] However, only the study of Doyle et al.[16] presented such a high distance, while the remaining studies presented maximum values of 30 m,[35] 333 m,[44] 27 m[45] and 116–162 m.[53]

Considering playing positions, only external intensity was addressed (see Table 6).[53] In general, central defenders covered the greatest total distance, central midfielders covered the greatest distance at 15–20 km·h^{-1} and wide midfielders covered the greatest distance at >20 km·h^{-1}. Central midfielders and forwards displayed the most DEC, and central defenders displayed the most ACC.

Overall team values for ACC and DEC were inconsistent because different thresholds were used in different studies,[16,44,45,53] making comparisons difficult concerning the frequency or distance when performing these actions. Despite methodological differences, the evidence indicates that more ACC and DEC are performed at higher competition levels and needs to be considered when designing training plans.

The present systematic review presented only two studies that considered a match-day minus approach,[16,44] reinforcing the need for intensity quantification following this approach in future studies. To clarify, match-day minus 5 (MD-5) means five days before the next match, MD-4 corresponds to four days before the next match, and so on. For instance, Mara et al.[44] presented energy expenditure and total distance outcomes using this approach while also using other GPS-derived measures. They recorded the highest energy expenditures and greatest total distances covered in the middle of the week. The same authors observed the lowest exergy expenditures and total distances covered in the first and last training sessions.[44] Doyle et al.[16] analysed several internal and external measures (see Table 4) and confirmed the pattern described in the previous study.[44] Despite only one study considered energy expenditure,[44] data from professional male soccer players seems to support this findings considering lower intensities in the day before and after the match while higher intensities were found in the middle days of the week.[14]

Match intensity

Internal match intensity was commonly quantified using s-RPE and HR measures. Three studies used s-RPE,[35,40,47] but data could be extracted from only two of these; the values ranged between 240 ± 79 and 892.50 ± 359.[35,40] These values differ significantly probably because the lower values were obtained from a team from the third Collegiate division, whereas the highest values were obtained from a second Collegiate division team. It is likely that the level of competition significantly affects s-RPE. Thus, we speculate that teams from professional first divisions would present even higher values recorded

in these two previous studies. Consequently, we suggest that future studies include s-RPE in match intensity analysis.

In the studies included in the present review, HR was the primary measure in six studies.[26,27,40,48,60,67] However, it was measured using different metrics (intensity, average, exertion) and it was sometimes considered in combination with GPS measures. These differences make it difficult to provide a range value. The HR measures used to quantify internal match intensity were a load-HR/GPS-based metric, different thresholds of HR%, HRaverage, HRexertion and HR maximum (HRmax).[26,27,39,40,48,60,67] HR average was the most often used, yielding a range interval of 162–173 bpm. However, this interval and measure did not correctly express intensity during the match, instead expressing only the range variety during several soccer actions. Therefore, we considered it worthwhile to apply such ranges in training sessions.

In elite female soccer players, the average HR during competitive matches ranged between 152 and 186 bpm, the equivalent of ~80% and 90% of HRmax.[26,43,85] HRmax was also used, although only one study provided a range interval of absolute values (181–194 bpm). In addition, in a semi-elite female soccer tournament, Strauss et al.[60] reported that female players spent most of the match in HR zones between 60 and 75 bpm and 75–85% of HRmax. Bozzini et al.[27] also showed that in out-of-conference matches, players spent ~34 min at 80–89% of HRmax and ~38 min at 90–100% of HRmax; meanwhile, during in-conference matches, they spent ~42 min at 80–89% of HRmax and ~34 min 90–100% of HRmax occurred. Future studies are needed to confirm such data.

Small-sided games are the activities most often used during soccer training sessions intended to mimic match demands. Mara et al.[75] demonstrated that small-sided games in soccer elicited a higher HR response (> 85% of HRmax) than medium and large-conditioned games. These results are in line with those reported by other studies[26,43,60,85] and should be considered by practitioners and coaches when attempting to manage the intensity of training sessions.

Considering external match intensity, total distance was the most commonly used measure. The range interval obtained from professional soccer players (≥ 18 years) was 5480–10581 m.[26,27,30,32,35–38,40,45,46,49,51–57,59,61,65,67] Amateur teams presented a lower range interval of 3994–8558 m.[42,60,63] The match is the most demanding situation in soccer. Although the total distance covered can serve as a basic and auxiliary indicator of the demands of the match, placing too much emphasis on this indicator can undervalue other unique aspects of matches.[12,26]

Regardless of how much total distance female soccer players cover, high-intensity activities need to be considered to gain a more insightful overview of match demands. In elite female soccer, Krustrup et al.[43] showed that these activities made up 5% of the total match time.

In this sense, several other running speed thresholds were used (commonly known as running, high-speed running (HSR), very HSR, and sprint distances). However, since different studies presented different intervals for each threshold, we opted to present the specific speed of distance covered.[26–28,30–32,35–38,40–43,45,46,49–63,65]

However, it has recently been suggested that employing male-related speed velocity zones thresholds in female team sports contexts could result in underestimations of external intensity.[86] Female-specific HSR velocity thresholds have been recommended in soccer due to physiological gender differences in physical fitness/capacity.[63,87] Absolute thresholds for high-speed running distance and very HSR distance range between 16.0 and 19.0 $km \cdot h^{-1}$ and between 20.2 and 22.5 $km \cdot h^{-1}$, respectively. Furthermore, these thresholds have been recommended for elite female soccer players.[86,87] Indeed, research on elite female soccer players advocated using > 19.8 $km \cdot h^{-1}$ for HSR distance and > 25.1 $km \cdot h^{-1}$ for very HSR or sprint distance as generic thresholds.[30] However, a recent study defined HSR as > 15 $km \cdot h^{-1}$ without including any other running or sprinting speeds.[88]

The number and average distance of sprints by professional players range between 20–35 and ~14–15 m per match, respectively, depending on the player's position.[50,62] When acknowledging the physical demands of matches beyond overall running, it is important to understand the intense periods and actions that occur (i.e. sprints, repeated sprints, ACC and DEC). This is because these factors substantially influence the biomechanical and cardiometabolic demands experienced by female players.[28,61] As mentioned before, these types of high-intensity efforts are critical components for practitioners and coaches to incorporate into their training strategies. For these reasons, we recommend that they be quantified.

Considering the previous information, we attempted to report the interval ranges for the most demanding actions in matches between all studies that included professional soccer female players. These ranges are as follows:

-distance ≥ ~14 $km \cdot h^{-1}$, 543–2520 m[26,28,30,35–37,40,51,52,54,65]

-distance ≥ ~18 $km \cdot h^{-1}$, 96–1680 m[28,30,32,35–38,40,45,46,49–52,54,59,61]

-distance ≥ 24 $km \cdot h^{-1}$, 1–20 to 460 m[26,28,30,35,36,49,52,62]
-numbers of ACC (>2 ms^{-2}) and DEC (<−2 ms^{-2}): 49–240 and 21–85.[40,45,54] Both measures were reported in terms of distance covered, in only one study[36] (see Table 5).

The previous thresholds were defined to include more studies from the systematic review, which means that all data must be carefully interpreted. Thus, we suggest

consulting all data in the tables to clarify the type of the teams and the specific thresholds used by each study.

Some studies considered player load.[32,35,55,56,61,65] Despite some differences in the literature, this external intensity measure is generally related to the magnitude of changes in acceleration along the three-movement axis.[89] However, when analysing this measure, a problem related to the equipment used emerges; consequently, a problem emerges regarding the equations used to calculate player intensity, which is crucial for its reproducibility.[89] Considering this point, we found a range interval of 848–1096 AU in female professional soccer players.[32,61,65]

The previous range intervals must be carefully interpreted because, even among professional soccer players, there were several contextual factors that could have influenced the results, such as the use of international and domestic matches,[26,37,49] friendly matches,[45,65] different thresholds[52] and match results.[32]

Moreover, other contextual factors, such as warm or hot environmental temperatures and the use of artificial turf, can also change the match demands by decreasing high-intensity running distances.[61,90] However, such variables were not addressed by the studies included in the present systematic review. When implementing position-specific training plans to accommodate overall match's physical demands, coaches should also consider the contextual factors necessary for successful outcomes in female players' physical performance and match preparation.

Finally, match intensity was also analysed in some studies by dividing matches into two halves. In these studies, higher values of external[26,28,38,49,51,60,63,65] and internal measures[26,51] were found in the first half than the second half. This information is very useful for coaches and their staff for a better preparation of their teams. For instance, it allows some simulations in training session with the specific intention of higher intensities in the first 45 min of training.

Match intensity by playing position

The position of a player influences the distance covered during soccer matches. In the present systematic review, some studies analysed playing positions regarding external match intensity (see Table 6).[26,28,30–32,38,40,46,50,51,53–57,59,60,62,63] However, Table 6 presents several divisions for playing positions, which makes it difficult to compare studies and establish range intervals. Thus, a general trend was found that midfielders typically cover the greatest total distance (8243–10985 m for professional players), followed by forwards (7483–10262 m for professional players) and defenders (7522–10229 m for professional players), whereas forwards and fullbacks (or wide midfielders) generally performed more high-intensity running thresholds and covered greater sprinting distances.[28,30,31,40,46,53,56,63]

Additionally, when playing positions were divided into defenders, midfielders and forwards, it was found that midfielders covered greater total and higher-intensity distances than other players.[26,38,54] However, three studies reported that forwards presented higher values of high-intensity measures.[57,62,63] Furthermore, if fullbacks were considered in addition to defenders, midfielders and forwards, the results showed that the most high-intensity actions were performed by fullbacks.[32,55,56,61]

Regarding internal match intensity, only two studies analysed playing positions.[40,51] One study showed that s-RPE and HR average were higher in central midfielders, followed by flank players. The other study[51] showed the highest HR average value for wide midfielders, which is in line with Mara et al.[40] This study also presented the highest HRmax values for forwards and wide midfielders, whereas other HR measures were identical for all playing positions.[51]

Considering external and internal match intensity quantification, studies that analysed goalkeepers reported that goalkeepers showed lower values than all other players for all measures. This is understandable due to the specific role of the position.[40,51,59] Finally, it should be reinforced that the previous information was consensual regardless of the type of soccer team, age of players and competition level (professional or amateur).

Study limitations, future directions and practical applications

This study presents some limitations that should be acknowledged and future directions that should be addressed. The small number of studies investigating intensity indicates that much more research is needed in female training and match intensity quantification. Additionally, more studies are needed considering player positions analysis in external (only one study included[53]) and internal (no studies included) training, as well as internal match (only two studies included[40,51]) intensity. In the same line, more studies considering the match-day minus approach (or simply considering each day of the microcycle) should be considered in future studies since only two studies[16,44] were found in the present systematic review.

Moreover, few studies analysed contextual variables such as player status[16] or match result,[32] and none of the included studies analysed match location or opponent quality, which can affect the results. In addition, few studies encompassed full seasons,[27,30,31,35,37,45,52,57,58,61,67] thus compromising data collection and consequently all generalisations.

Furthermore, the reviewed studies involved players of different competition levels from different countries with a wide range interval for age (15–31 years), which constitutes significant differences in context. This lack of uniformity in

classifying running speed and acceleration thresholds limits comparisons between studies, thereby making it difficult to generalise their results. Finally, the fact that few studies analysed young soccer players or amateur teams using different measures did not allow us to obtain reference values.

Although the results suggested that the menstrual cycle phase does not significantly influence the training or match physical performance of female soccer players,[41] monitoring the menstrual cycle phases during training is recommended in future studies.[91]

Despite the information presented in the previous paragraphs, the present study constitutes a relevant tool for the training and match intensity quantification of female players (professional and amateur). This tool can be used by coaches, their staff, and practitioners as a reference for future studies. For instance, the range values presented in this study can be replicated by other coaches, staffs or researchers. Such information will allow a better training intensity application for female soccer players.

Conclusions

This study provided range values for the main and most often used measures of internal and external training and match intensity (in absolute values) obtained from overall professional teams. Specifically, range intervals of s-RPE, RPE, TRIMP, total distance and distance >19.4 km·h^{-1} were provided regarding training; range intervals of s-RPE, hear rate average and maximum, total distance, distance ≥ 14 km·h^{-1}, ≥ 18 km·h^{-1}, number of ACC and DEC (>2 ms^{-2}) and player intensity were provided regarding matches. This work provides range values coaches, their staff and practitioners can use to help female soccer players achieve desirable competitive levels. Coaches can attempt to replicate such values or even increase them, especially during training sessions.

Nonetheless, the intervals provided were retrieved from specific scenarios; when analysed, the following contextual variables must be taken into account: age, the skill level of players, level of competition, as well as other contextual factors, such as match results, match location, quality of opponents, playing positions and player status. Future research should consider attempting to better understand the methodology used to quantify training and explore how practical implications for real-training scenarios can be applied based on the collected measures.

Finally, GPS-based thresholds of running distances and accelerometry-based variables of intensity vary widely between studies, making it difficult for all possible comparisons to be made. Thus, we could not suggest specific thresholds for all variables.

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