



# Reference values for external and internal training intensity monitoring in professional male soccer players: A systematic review

International Journal of Sports Science & Coaching  
1–25

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DOI: 10.1177/17479541211072966

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## GQ2 Abstract

**GQ4** One of the possibilities for organising different studies and providing some reference values or benchmarks is to summarise all information. Such a possibility could help coaches and practitioners identify typical values based on specific conditions and eventually use benchmark values to compare players against. The current systematic review was carried out to identify and summarise studies that have examined external and internal training intensity monitoring and to provide reference values for the main measures in professional male soccer players. 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. From the 2404 studies initially identified, 25 were fully reviewed, and their outcome measures were extracted and analysed. From these, the following range intervals by overall team were found: session rated perceived exertion (s-RPE) = 26–936 AU, total distance = 2143–9540 m and distance >14 km/h = 410–1884 m, distance >18 km/h = 7–541 m, distance >24 km/h = 1–190 m, acceleration number >3 m.s<sup>-2</sup> = 9–195, deceleration number >-3 m.s<sup>-2</sup> = 10–157 and player load = 310–774 AU. Additionally, range intervals for player positions and a match-day minus approach were provided. This study provided reference values of professional male players for the main internal and external intensity measures. Altogether, they can be used by coaches, their staff, or practitioners to achieve desired competitive levels. They can replicate such values or even increase the numbers presented in training sessions.

## Keywords

football, load quantification, men, training load, workload

## Introduction

Monitoring training loads has become a widely used process in soccer,<sup>1</sup> and it is often considered in research and daily practice in clubs.<sup>2</sup> Based on recent research, the term “intensity” should be used instead of “training load” or “load,” and the term “volume” should be used instead of “work” or “workload” according to the “International System of Units.” For better clarity, the present research followed such guidelines.<sup>3</sup> Independent of the context (e.g. competitive, financial), controlling the implications of training intensity is well-recognised by practitioners as a determinant process in programming and managing training.<sup>4,5</sup> Training intensity is a complex process, as it depends on the mechanical stimuli provided by the training drills, and such stimuli influence the physiological responses of players differently.<sup>6</sup> Thus, the concept of training intensity is usually classified into internal and external dimensions.<sup>7</sup>

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**Table 1.** Eligibility criteria.

PICOS	Inclusion Criteria	Exclusion Criteria
1 - Population	Healthy professional male soccer players.	Studies conducted with young or amateur players or in other sports, or with female populations.
2 - Intervention/ Exposure	Exposure to entire training sessions for number of weeks and sessions included (minimum one week).	No exposure to training sessions (e.g. specific exercises only reported; only matches; only simulated 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 among the included in internal intensity (e.g. heart rate, rate of perceived exertion) and/or external intensity (e.g. distances covered at different speed thresholds, acceleration-based measures) in absolute values. Whenever relative values allow to calculate absolute values, the study will be included.	Absence of data characterizing the intensity during the training 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 indexes calculations will also be excluded (e.g. accumulated weekly load, training monotony, strain, ACWR, EWMA).
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.

The external dimension in soccer usually characterises the physical demands that are imposed during exercise.<sup>8</sup> In soccer, external demands are assessed using position-based microelectromechanical systems (e.g. local positioning systems, global positioning systems, inertial measurement units).<sup>9</sup> Three main categories of variables can be included in external measures on soccer: (i) distance-based variables (i.e. controlling the distances covered at different speed thresholds); (ii) changes in velocity (i.e. controlling the accelerations and decelerations or changes-of-direction performed at different intensities); and (iii) events derived from inertial measurement units (e.g. mechanical work, player load, imbalances).<sup>10</sup>

The internal dimension represents players' psychophysiological or biological responses to the external intensity,<sup>11</sup> which may differ between players for many reasons, such as individual fitness levels, environmental factors, or readiness status.<sup>12</sup> In soccer, the instruments typically used for measuring internal demands are heart rate sensors, blood lactate devices, and questionnaires of effort (e.g. rate of perceived exertion [RPE]).<sup>13</sup> Some common internal measures are (i) heart rate measures (e.g. percentage of time covered at a given intensity, training impulse), (ii) RPE (e.g. measured using different scores and scales), and (iii) blood lactate.<sup>9</sup>

In addition to the acute measures extracted for a training session, all these measurements are normally calculated per session or on a weekly basis. For example, heart rate and RPE can be calculated for each session in the form of intensity or as volume using the Edwards training impulse or session-RPE.<sup>14,15</sup> All internal and external measures can also

be calculated weekly using volume as an "acute load," training monotony, or training strain.<sup>16</sup> Between-week comparisons can also be made to calculate the "acute: chronic workload" measure or the "acute-chronic workload index".<sup>17,18</sup>

Regardless of whether intensity measures are controlled by session or by week, much research has described the typical values of training intensity in different competitive contexts (e.g. professional, amateur, youth)<sup>19,20</sup> and schedules (e.g. normal, congested).<sup>21</sup> Additionally, differences between playing positions or starting status,<sup>22</sup> as well as between official and friendly matches<sup>23</sup> have been analysed. However, some typical issues related to such research are the small number of players included and the fact that only one team is studied under specific conditions and scenarios.<sup>24,25</sup> Such limitations make it difficult to generalise the findings and compare or define normality values for coaches and sports scientists to use as benchmarks in practice.

One way to organise the different studies and provide reference values or benchmarks is to summarise the evidence through a systematic review. Although such an approach is possible, as far as we know, no systematic review using such an approach has been produced. Such a possibility may help coaches and practitioners identify typical values based on specific conditions and eventually use benchmark values against which they can compare their players. Thus, the aims of this systematic review are to identify and summarise studies that have examined external and internal training intensity monitoring and to provide reference values for the main measures among professional male soccer players.

## Methods

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines were followed to write this systematic review<sup>26</sup> and guidelines for performing systematic reviews in sport sciences.<sup>27</sup> The protocol of the systematic review was *a priori* registered in the International Platform of Registered Systematic Review and Meta-Analysis Protocols with the number INPLASY202180057 and the DOI number 10.37766/inplasy2021.8.0057.

### 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 study to locate potentially relevant studies was independently executed by two of the authors (A.M.V. and M.R.G.). 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 (R.O.). Possible errata for the included articles were considered.

### Information sources

The following electronic databases were used to search for relevant publication on the 3 of July of 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 (“internal load” OR “external load” OR “workload” OR “training load” 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) for process the data extraction. The design followed the recommendations of the Cochrane Consumers and Communication Review Group’s data extraction template.<sup>28</sup> 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 (A.M.V. and M.R.G.). In the cases of discrepancies, a discussion was performed with the participation of a third author (R.O.).

### Methodological assessment

The methodological quality was assessed using the methodological index for non-randomised studies (MINORS) by two authors (A.M.V. and M.R.G.).<sup>29</sup> The global ideal score being 16 for non-comparative studies. MINORS consists of twelve items, four of which are only 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.<sup>29,30</sup> Recently, it was also used in another systematic review about training intensity in young soccer players.<sup>31</sup>

## Results

### Study identification and selection

A total of 2404 (i.e. FECYT: 1481; PubMed: 806; Scopus: 117) original articles were initially retrieved from the databases mentioned above, of which 835 were duplicates. Thus, a total of 1569 original articles were found. After this, a total of 1530 articles were excluded after checking their titles and abstracts. The full texts of the remaining 39 articles were checked, leading to the exclusion of three more articles according to criterion number (No) 1, another three articles according to criterion No 2, and 14 articles according to criterion No 4. Six more articles were included from additional sources. A total of 25 articles met all the inclusion criteria and were included in the qualitative synthesis. All steps followed when selecting the articles are listed in Figure 1.

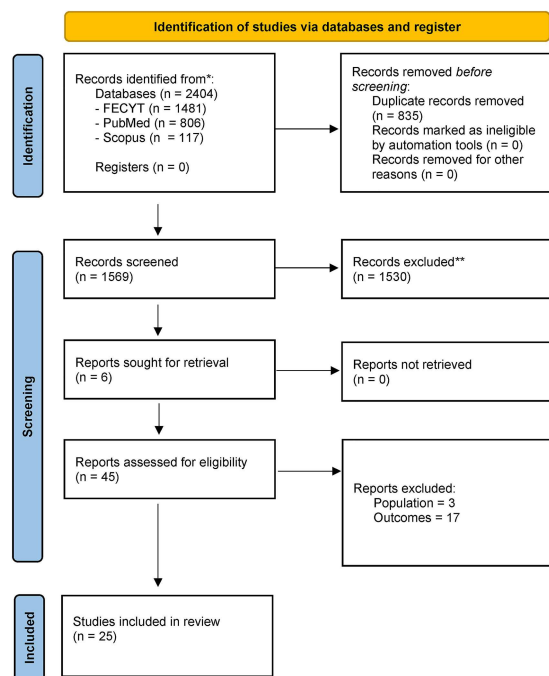
### Methodological quality

The overall methodological quality of the cross-sectional studies is presented in Table 2.

## Results of the studies

### Study characteristics

Table 3 presents the characteristics of the studies included in the present systematic review. From the 25 studies, a total sample of 505 soccer players (mean age = 24 years) was included in the analysis. Eighteen studies<sup>20,32,35–38,40–44,46–49,52,54,55</sup> were



**Figure 1.** Preferred reporting item for systematic reviews and meta-analyses (PRISMA) flow diagram.

conducted in 1<sup>st</sup> league divisions, while seven studies<sup>33,34,39,45,50,51,53</sup> were conducted in 2<sup>nd</sup> league divisions. The studies had different durations, including a minimum of two weeks and a maximum of a full season.

Of the included studies, six analysed external intensity,<sup>33,34,38,44,45,55</sup> three analysed internal intensity,<sup>35,40,53</sup> and 16<sup>20,32,36,37,39,41–43,46–52,54</sup> analysed external and internal intensities in simultaneously.

### Results of external and internal training/match

Table 4 presents the external and internal intensity results as averages  $\pm$  standard deviation or range intervals (minimum and maximum), according to the match day minus (MD-) approach. Table 5 also includes range intervals according to player position in a column designed as the overall team, which avoids the need to include more rows.

Duration (in min) was also included whenever the data were reported.

In the last rows of the internal and external intensities of Table 4, range interval values for the main measures were presented.

Table 5 presents the results of external and internal intensities by player position and for overall teams based on means  $\pm$  standard deviation or range interval (minimum and maximum). The range interval values for the main measures are presented in the last rows for internal and external intensities in Table 5.

**Table 2.** Methodological assessment using MINORS checklist.

Study	1	2	3	4	5	6	7	8	Score
32	1	2	1	2	0	2	2	1	11/16
33	2	2	1	2	1	2	2	2	14/16
34	2	2	2	2	1	2	2	2	15/16
35	2	2	2	2	1	2	2	2	15/16
36	2	2	1	2	1	2	2	2	14/16
37	2	1	1	2	0	2	2	1	11/16
38	2	2	1	1	0	2	2	1	11/16
39	2	1	2	2	0	2	1	2	12/16
40	2	2	1	1	1	2	2	1	12/16
41	2	2	1	1	1	2	2	1	12/16
42	1	2	1	1	1	2	2	1	11/16
43	2	2	1	2	1	2	2	2	14/16
44	1	2	2	1	0	2	2	1	11/16
45	2	1	2	2	0	2	2	2	13/16
46	2	2	2	2	1	2	2	1	14/16
20	2	2	2	2	1	2	2	1	14/16
47	2	2	2	2	1	2	2	2	15/16
48	2	2	2	2	1	2	2	2	15/16
49	2	2	1	1	1	2	2	1	12/16
50	2	2	2	2	0	2	2	1	13/16
51	2	2	1	1	1	2	2	1	12/16
52	2	2	2	1	1	2	2	2	14/16
53	2	2	1	2	1	2	2	2	14/16
54	1	2	1	2	0	2	2	1	11/16
55	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.

Table 6 presents external and internal intensities by the MD- method. Due to differences in scenarios from study to study, we used MD-5, MD-4, MD-3, MD-2, MD-1, MD + 1, and MD + 2 to consider all seven days of the week. The range interval values for the main measures are presented in the last rows for external and internal intensities in Table 6.

### Discussion

The objectives of this systematic review were to identify and summarise studies that have examined external and internal training intensity monitoring and to provide reference values for the main measures in professional male soccer players. The results section included tables presenting training values by overall team (Table 4), player position (Table 5), and using the match-day minus (MD-) approach (Table 6). After data extraction, player status

**Table 3.** Study characteristics.

Study	Sample	Study duration	Instruments / Internal measures	Instruments / External measures
32	N: 33	12 microcycles	Polar Electro Oy, Finland: hear rate (bpm)	10 Hz GPS (Catapult MiniMaxx S4, Firmware 6.7; Catapult, Australia) Total Distance (m) Distance < 10.8 km/h (m) Distance >20.9 km/h (m) Distance >20.9 km/h NR Distance >24.1 km/h (m) Distance >24.1 km/h NR ACC >1 m.s <sup>-2</sup> (m) DEC <-1 m.s <sup>-2</sup> (m) Player load (AU)
33	N: 16	6-weeks period	-	10-Hz GPS and 100-Hz triaxial accelerometer (WIMU PRO, RealTrack Systems, Almeria, Spain): Total distance Distance >14 km/h Distance >21 km/h Acceleration NR (>3 m.s <sup>-2</sup> ) Player load (AU)
34		7-weeks period	-	GPS devices (10 Hz, JOHAN, Noordwijk, Netherlands): Total Distance (m) Distance 0–6.9 km/h (m) Distance 7–13.9 km/h (m) Distance 14–20 km/h (m) Distance > 20 km/h (m) Maximal Speed (km/h)
35	N: 35	I in-season	s-RPE (CR-10, AU)	-
36	N:23	26-weeks period	s-RPE (CR-10, AU)	10-Hz global position system (GPS) (Playertek, Catapult Innovations, Australia) Total Distance (m) Distance < 18 km/h Distance > 18 km/h ACC >2 m.s <sup>-2</sup> (m) DEC <-2 m.s <sup>-2</sup> (m) Player load (AU)
37	N: 30	I in-season	s-RPE (CR-10, AU)	18 Hz GPS (GPEXE Pro®, GPEXE, Udine, Italy) Metabolic Power average (w/kg) MPev (≥ 20w/k) Acceleration NR >2 m.s <sup>-2</sup> Deceleration NR <2 m.s <sup>-2</sup> Total Distance (m) Distance 0–7 km/h (m) Distance <14 km/h (m) Distance 18–21 km/h (m) Distance 21–24 km/h (m)
38	N:11 FT N: 9 U19	I in-season	-	10 Hz GPS OptimEye S5 (Catapult Sports, Melbourne, Australia) Total distance (m) Distance 12–15 km/h (m) Distance 15–20 km/h (m) Distance 20–25 km/h (m) Distance >25 km/h (m)

(continued)

Table 3. (continued)

Study	Sample	Study duration	Instruments / Internal measures	Instruments / External measures
39	N: 13	6-week period	Polar Team Pro tracking system (Polar Electro, Sports instruments, Kempele, Finland): Heart Rate at 50–59.9% 60–81.9% 82–89.9% 90–94.9% 95–100%	Polar Team Pro tracking system (Polar Electro, Sports instruments, Kempele, Finland) Distance 0–7.9 km/h (m) Distance 8–14.3 km/h (m) Distance 14.4–19.7 km/h (m) Distance 19.8–24.9 km/h (m) Distance >25 km/h (m) Total distance (m) Sprint NR Total DEC NR DEC NR (>-3 m.s <sup>-2</sup> ) DEC NR (-2.99- -2 m.s <sup>-2</sup> ) DEC NR (-1.99–1 m.s <sup>-2</sup> ) DEC NR (< -1 m.s <sup>-2</sup> ) Total ACC NR ACC NR (<1 m.s <sup>-2</sup> ) ACC NR (1–1.99 m.s <sup>-2</sup> ) ACC NR (2- 2.99 m.s <sup>-2</sup> ) ACC NR (>3 m.s <sup>-2</sup> )
40	Pre-season N: 12 In-season N: 10	1-week, pre-season 1-week, in-season	(Polar Team System I, Kempele, Finland): Heart rate (bpm) RPE (CR-10, AU) s-RPE (CR-10, AU)	-
41	N: 26	36-week period	s-RPE (CR-10, AU)	GPS (GPSports SPI Pro X, Canberra, Australia): Total distance (m) Distance >14.4 km/h (m) Distance >18.8–25.2 km/h (m)
42	N: 30	6-weeks, pre-season 39 weeks, in-season	s-RPE (AU) (CR-10, AU)	GPS (GPSports© SPI Pro X, Canberra, Australia): Total distance (m) Distance >19.8 km/h (m)
43	N: 1	1 Full Season	S-RPE (CR-10, AU)	GPS (Optimeye G5; firmware version 717; Catapult Sports, Australia) Total distance (m) ACC NR (>3 m.s <sup>-2</sup> ) DEC NR (<3 m.s <sup>-2</sup> ) Player load (AU)
44	N: 24	42-weeks period	-	10 Hz GPS (Viper Pod, 50 gr, 88 × 33 mm; Statsports Viper; Northern Ireland): Total distances (m) Distance >19.8 km/h (m) Distance >25.2 km/h (m) ACC NR (>3 m.s <sup>-2</sup> ) DEC NR (<-3 m.s <sup>-2</sup> )
45	N: 20	2-weeks period	-	10 Hz GPS (STATSports Viper Pod 2, Northern Ireland) HMLD (>25.5 W.kg <sup>-1</sup> ) (m) HML NR (>25.5 W.kg <sup>-1</sup> ) ACC NR (>3 m.s <sup>-2</sup> ) DEC NR (<-3 m.s <sup>-2</sup> ) Impacts NR Dynamic stress load (AU)
46	N: 13	39-weeks period	s-RPE (CR-10, AU)	10 Hz GPS (Viper pod 2, STATSports,

(continued)

**Table 3.** (continued)

Study	Sample	Study duration	Instruments / Internal measures	Instruments / External measures
				Belfast, UK): Total distance (m) Distance 0–10.9 km/h (m) Distance 11–13.9 km/h (m) Distance 14–18.9 km/h (m) Distance 19–23.9 km/h (m) Distance > 24 km/h (m)
20	N: 19	39-weeks period	s-RPE (CR-10, AU)	10 Hz GPS (Viper pod 2, STATSports, Belfast, UK): Total distance (m) Distance > 19 km/h (m)
47	N: 20	39-weeks period	s-RPE (CR10, AU)	10 Hz GPS (Viper pod 2, STATSports, Belfast, UK): Total distance (m) Distance > 19 km/h (m)
48	N: 20	39-weeks period	s-RPE (CR10, AU)	10 Hz GPS (Viper pod 2, STATSports, Belfast, UK): Total distance (m) Distance > 19 km/h (m)
49	N: 16	6-week period	s-RPE (CR10, AU)	10 Hz GPS (Catapult Innovations, Melbourne, Australia): Total distance (m) Distance 21.6–25.2 km/h (m) Distance >25.2 km/h (m)
50	N: 13	8-weeks period	s-RPE (CR-10, AU) RPE (CR-10, AU)	10 Hz GPS (BT-Q1000 Ex, QStarz, Taipei, Taiwan): Total distance (m) Distance 14.4–18.8 km/h (m) Distance 19.9–25.1 km/h (m) Distance $\geq$ 25.2 km/h (m)
51	N: 15	29 training sessions	Polar Electro, Kempele, Finland: hear rate Bamister Trimp (AU) Edwards Trimp (AU) RPE (CR-10, AU) s-RPE (CR-10, AU)	MinimaxX 2.0 GPS (Firmware version 6.59, Catapult Innovations, Scoresby, Australia): Total distance (m) Distance < 14.4 km/h (m) Distance $\geq$ 14.4 km/h (m) Distance > 19.8 km/h (m)
52	N: 20	15 training sessions	Polar Electro Inc., Lake success, NY, USA: heart rate	10 Hz GPS (Viper Pod, 50 gr, 88 × 33 mm, STATSports Viper, Northern Ireland): ACC NR >2 m.s <sup>-2</sup> ACC NR >2.5 m.s <sup>-2</sup> ACC NR >3 m.s <sup>-2</sup> DEC NR >-2 m.s <sup>-2</sup> DEC NR >-2.5 m.s <sup>-2</sup> DEC NR >-3 m.s <sup>-2</sup> Total distance (m) Distance >14.4 km/h (m) Distance 14.4 19.8 km/h (m) Distance >19.8 km/h (m) Impacts NR Dymanic stress load (AU) HMLD (m)
53	N: 18	48-weeks period	s-RPE (CR10)	-
54	N: 28	I Full Season	Polar Electro Oy, Kempele, Finland: Heart Rate maximal >90%	31 Hz LPS (version 05.91 T; Inmotiotec GmbH, Regau, Austria):

(continued)

Table 3. (continued)

Study	Sample	Study duration	Instruments / Internal measures	Instruments / External measures
55	N: 10	17-day period	-	Total distances (m) Distance 14.4–19.8 km/h (m) Distance >19.8 km/h (m) ACC NR 1.5–3 m.s <sup>-2</sup> ACC NR >3 m.s <sup>-2</sup> DEC NR -1.5- -3 m.s <sup>-2</sup> DEC NR < -3 m.s <sup>-2</sup> Metabolic power (m) GPS (GPSports SPI Pro X 5 Hz, Canberra, Australia): Distance >14.4 km/h (m)

au: arbitrary units; GPS: global positioning system; LPS: local positioning system; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; MPev: mean metabolic power of high intensity actions; NR: number; HML: high metabolic load; HMLD: high metabolic load distance; bpm: beats per minute.

was also considered. Accordingly, the present discussion was organised into the following subsections.

### Training intensity by overall team

The main results for the external intensity measures considering overall team values showed that the largest range interval for total distance was 2143–9540 m, in the study of Scott et al.<sup>51</sup> Several studies align with this interval.<sup>20,32–34,37–39,41–52,54</sup> In fact, the interval provided was independent of some contextual variables, such as data collected from goalkeepers,<sup>43</sup> data from weeks with one or more matches,<sup>38,46</sup> match result,<sup>47</sup> match location,<sup>37,48</sup> and player status.<sup>45</sup>

Regarding the main speed thresholds used, the following speeds and intervals were found:

- >14 km/h, 410–1884m<sup>33,34,39,41,46,54</sup>
- >18.8 km/h, 7–541m<sup>20,32–34,39,41,42,44,46–49,54</sup>
- >24 km/h, 3–190m<sup>20,32,39,41,44,46,49</sup>

Regarding the number of acceleration (ACC) and deceleration (DEC) from >3 m.s<sup>-2</sup>, the following range intervals were found: ACC, 3–195;<sup>33,39,43–45,54</sup> DEC, 10–157.<sup>39,44,45,54</sup> In fact, only the study of Martín-García et al.<sup>44</sup> showed values as high as 195 ACC efforts and 157 DEC efforts; the other studies found the highest values for ACC and DEC to be around 66 and 53. The difference in the results could be associated with the different durations of the studies—Martín-García et al.<sup>44</sup> analysed a full season (42 weeks), which could have influenced the results. One study also analysed goalkeepers' ACC efforts, which presented a range interval of 5–12,<sup>43</sup> which agrees with some previous studies.<sup>33,39</sup>

Another variable used to quantify external intensity is the player load. The range interval for player load was 310–774 AU.<sup>32,33</sup> The minimum value presented by

goalkeepers was 282.<sup>43</sup> Despite some differences in the literature, this measure is generally calculated as the sum of the accelerations along the three-movement axis. However, a problem that emerges when analysing this measure is related to the equipment used and the equation consequently used to calculate player load, which is crucial for its reproducibility.<sup>56</sup>

Internal intensity was mainly characterised by session rated perceived exertion (s-RPE). Accordingly, the range interval was 26–936 AU.<sup>35,40,46–48,50,51</sup> However, only one study found the highest value of 936,<sup>51</sup> while the other studies provided the second-highest value of 411 AU.

### Training intensity by player position

Total distance was the most-often quantified external variable. Overall, there were similar range intervals between player positions, but the lowest values were produced by strikers (ST) and the highest by central midfielders (CM).

Some studies showed significant differences in the early season between all positions: CM and wide midfielders (WD) covered the greatest total distance, and central defenders (CD) displayed the lowest values.<sup>42</sup> WD and CM also covered a greater total distance than WM in another study.<sup>20</sup> This can be justified because the coaches emphasise increasing the physical conditioning of the team in the initial phases of the season as a continuation of the pre-season, which makes periodisation flexible.<sup>42</sup>

Furthermore, Malone et al.<sup>43</sup> conducted a study during the pre-season and in-season and reported significant differences between player positions in terms of total distance. In the pre-season, CD reported significantly lower values compared to CM and WD, and ST also reported significantly lower total distance values than to CM and WD. In the in-season, CM covered significantly more total distance than CD, ST, and WM, while WD showed significantly higher values than CD and ST. These significant differences

**Table 4.** Results for external and internal load by average or range intervals of training days of the week.

Study	Measures	Contextual variable / Data	Contextual variable / Data	Contextual variable / Data
<b>External Load</b>				
32	Duration (min-max)	60–86	-	-
	Total Distance (m)	3493–6234		
	Distance < 10.8 km/h (m)	2829–4568		
	Distance >20.9 km/h (m)	23–190		
	Distance >20.9 km/h NR	3–14		
	Distance >24.1 km/h (m)	6–46		
	Distance >24.1 km/h NR	0–3		
	ACC >1 m.s <sup>-2</sup> (m)	310–574		
	DEC <-1 m.s <sup>-2</sup> (m)	269–501		
	Player load (AU)	392–622		
33	Duration (min-max)	50–90	-	-
	Total distance	3065–7281		
	Distance >14 km/h (m)	410–909		
	Distance >21 km/h (m)	190–504		
	ACC NR (>3 m.s <sup>-2</sup> )	3–10		
	Player load (AU)	330–774		
34	Duration (min)	ND	-	-
	Total Distance (m)	4585–7063		
	Distance 0–6.9 km/h (m)	2720–3553		
	Distance 7–13.9 km/h (m)	1379–2825		
	Distance 14–20 km/h (m)	343–990		
	Distance > 20 km/h (m)	138–391		
	Maximal Speed km/h	26–30		
43	Data from Goalkeeper		-	-
	Duration (min-max)	58–85		
	Total distance (m)	2553–3742		
	ACC NR (>3 m.s <sup>-2</sup> )	5–12		
	DEC NR (<-3 m.s <sup>-2</sup> )	4–7		
	Player load (AU)	282–403		
46	Matches per week	1-Match week	2-Matches week	3-Matches week
	Duration (min-max)	32–88	31–98	74–90
	Total distance (m)	2735–6689	3912–7532	3620–6692
	Distance 0–10.9 km/h (m)	2412–4560	2910–5646	2995–4520
	Distance 11–13.9 km/h (m)	176–1025	406–1106	290–942
	Distance 14–18.9 km/h (m)	118–820	289–780	255–901
	Distance 19–23.9 km/h (m)	17–285	50–398	70–281
	Distance >24 km/h (m)	3–107	14–90	7–50
47	Data according match result	Win	Draw	Defeat
	Duration (min-max)	17–85	15–95	17–92
	Total distance (m)	3629–7006	3391–7112	3236–7326
	Distance >19 km/h (m)	86–291	97–284	55–307
48	Data according match location	Home	Away	-
	Duration (min-max)	22–86	16–86	
	Total distance (m)	3645–7051	3452–7211	
	Distance >19 km/h (m)	66–254	68–316	
54	Duration (min-max)	59–88	-	-
	Total distances (m)	3848–7267		
	Distance 14.4–19.8 km/h (m)	328–510		
	Distance >19.8 km/h (m)	106–249		
	ACC NR 1.5–3 m.s <sup>-2</sup>	55–131		
	ACC NR >3 m.s <sup>-2</sup>	26–66		
	DEC NR -1.5- -3 m.s <sup>-2</sup>	44–98		
	DEC NR < -3 m.s <sup>-2</sup>	23–49		

(continued)

Table 4. (continued)

Study	Measures	Contextual variable / Data	Contextual variable / Data	Contextual variable / Data
45	Metabolic power (m)	565–1363		
	Player status	Starters	Non-starters	-
	Total distance (m)	3634 ± 1251	3221 ± 880	
	HMLD (>25.5 W.kg <sup>-1</sup> ) (m)	232 ± 102	206 ± 111	
	HML NR (>25.5 W.kg <sup>-1</sup> )	46 ± 24	45 ± 20	
	ACC NR (>3 m.s <sup>-2</sup> )	42 ± 20	40 ± 18	
	DEC NR (<-3 m.s <sup>-2</sup> )	239 ± 159	202 ± 138	
	Impacts NR	37 ± 61	22 ± 26	
50	Dynamic stress load (AU)	102 ± 56	105 ± 52	
	Duration (mean)	105 ± 23	105 ± 23	-
	Total distance (m)	6384 ± 1593	Individualised	
	Distance 14.4–18.8 km/h (m)	531 ± 318	5000 ± 1767	
51	Distance 19.9–25.1 km/h (m)	178 ± 173	332 ± 208	
	Distance ≥25.2 km/h (m)	25 ± 49	190 ± 133	
	Duration (mean)	~73	-	-
	Total distance (m)	2143–9540		
52	Distance <14.4 km/h (m)	2014–8237		
	Distance ≥14.4 km/h (m)	106–1343		
	Distance >19.8 km/h (m)	7–541		
	Duration (mean)	79 ± 13	-	-
	ACC NR >2 m.s <sup>-2</sup>	134 ± 29		
	ACC NR >2.5 m.s <sup>-2</sup>	79 ± 20		
	ACC NR >3 m.s <sup>-2</sup>	43 ± 13		
	DEC NR >2 m.s <sup>-2</sup>	127 ± 33		
	DEC NR >2.5 m.s <sup>-2</sup>	76 ± 23		
	DEC NR >3 m.s <sup>-2</sup>	43 ± 16		
37	Total distance (m)	5426 ± 869		
	Distance >14.4 km/h (m)	771 ± 258		
	Distance 14.4–19.8 km/h (m)	585 ± 183		
	Distance >19.8 km/h (m)	187 ± 111		
	Impacts NR	3116 ± 906		
	Dymanic stress load (AU)	149 ± 61		
	HMLD (m)	848 ± 214		
	Data according to match location	Home	Away	-
	Duration (min)	ND	ND	
	Metabolic Power average (w/kg)	6 ± 1	7 ± 1	
38	MPev (≥ 20 w/kg)	28 ± 2	29 ± 2	
	ACC NR >2 m.s <sup>-2</sup>	38 ± 16	44 ± 16	
	DEC NR <2 m.s <sup>-2</sup>	36 ± 16	41 ± 16	
	Total Distance (m)	4025 ± 1188	4633 ± 1243	
	Distance 0–7 km/h (m)	2038 ± 547	2370 ± 569	
	Distance <14 km/h (m)	3275 ± 941	3837 ± 1006	
	Distance 18–21 km/h (m)	152 ± 127	185 ± 102	
	Distance 21–24 km/h (m)	69 ± 59	93 ± 81	
	Matches per Week	1-Match Week	2-Matches Week	-
	Duration (mean)	~79	~73	
55	Total distance (m)	~6186	~6116	
	Distance 12–15 km/h (m)	~691	~706	
	Distance 15–20 km/h (m)	~573	~588	
	Distance 20–25 km/h (m)	~191	~197	
	Dsistance >25 km/h (m)	~66	~59	
	Distance >14.4 km/h (m)	Non-Extractable data	-	-

(continued)

**Table 4.** (continued)

Study	Measures	Contextual variable / Data	Contextual variable / Data	Contextual variable / Data
<b>Reference values</b>	<b>Total Distance (m)</b>	<b>2143–9540</b>		
	<b>Distance &gt; 14 km/h (m)</b>	<b>410–1884</b>		
	<b>Distance &gt; 18 km/h (m)</b>	<b>7–541</b>		
	<b>Distance &gt; 24 km/h (m)</b>	<b>1–190</b>		
	<b>ACC (&gt;3 m.s<sup>-2</sup>) (NR)</b>	<b>9–195</b>		
	<b>DEC (&lt; -3 m.s<sup>-2</sup>) (NR)</b>	<b>10–157</b>		
	<b>Player Load (AU)</b>	<b>310–774</b>		
<b>Internal Load</b> 32	Heart Rate maximal >90% (min)	3–7		
35	Matches per week	1-match week	2 matches-week	-
	s-RPE (AU)	308 ± 160	246 ± 154	
40	Season period	Pre-season	In-season	-
	Duration (mean)	92 ± 17	83 ± 15	
	Heart Rate (bpm)	124 ± 7	112 ± 7	
	RPE (AU)	4 ± 1	3.8 ± 1	
	s-RPE (AU)	176.2 ± 18.6	160 ± 24	
46	Matches per week	1-match week	2-matches week	3-matches week
	RPE	2.2–5.4	2.5–4.8	2.6–3.6
	s-RPE (AU)	169–432	168–388	241–316
47	Data according to match result	Win	Draw	Defeat
	s-RPE (AU)	26–376	29–404	32–361
48	Data according to match location	Home	Away	-
	s-RPE (AU)	46–392	23–368	
50	RPE (AU)	3.6 ± 1.8	-	-
	s-RPE (AU)	411 ± 267		
51	Bamister Trimp (AU)	21–168	-	-
	Edwards Trimp (AU)	51–368		
	RPE (AU)	1–8		
	s-RPE (AU)	38–936		
54	Heart Rate maximal >90% (min)	3–17		
<b>Reference values</b>	<b>s-RPE (AU)</b>	<b>26–936</b>		

min: minutes; ACC: acceleration; DEC: deceleration; HR: heart rate; NR: number; ND: non described; HSR: high-speed running distance; HMLD: high metabolic load distance; AU: arbitrary units; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; MPev: mean metabolic power of high intensity actions; HML: high metabolic load; HMLD: high metabolic load distance.

were confirmed by Owen et al.,<sup>49</sup> who revealed that CD presented lower values than other players while CM and WM covered significantly higher total distances. The greater total distance for CM and WM (and sometimes WD) can be attributed to their specific tactical roles liaising between defending and attacking, thus assuming a larger action zone both in training sessions and official matches.<sup>49</sup> Thus, it can be suggested that these positions require a higher aerobic profile than others.<sup>57</sup>

When analysing high-intensity thresholds, WM presented the highest value at the distance of >14 km/h, while CM presented the lowest value; the remaining positions were quite similar. At a distance of >18 km/h, WD presented the highest value, while CD presented the

lowest value; the remaining positions were quite similar. At a distance of >24 km/h all positions presented similar values.

Considering the distances covered at different speeds, players covered longer distances at a running speed (up to 14.39 km/h) in training sessions than in matches for all positions.<sup>39</sup>

ST and CD showed significant differences between training sessions and matches at running speeds of 14.4–19.97 km/h. However, CM achieved a greater distance.<sup>39</sup> CD covered a significantly smaller distance at a running speed of >19.97 km/h than all other positions.<sup>42</sup> At this speed, there were significant differences between CD and WD in the early season.<sup>20</sup> We noticed some cause for

**Table 5.** Results for external and internal training load by player positions.

External Load								
Study	Measures	Goalkeeper	Central defenders	Wide defenders	Central midfielders	Wide midfielders	Forwards/ strikers	Overall team
32	Total Distance (m)	-	4834	4846	5463	4971	4809	4809–5463
	Distance < 10.8 km/h (m)	-	3919	3600	3931	3380	3698	3380–3919
	Distance >20.9 km/h (m)	-	79	118	102	102	94	79–118
	Distance >20.9 km/h NR	-	6	10	8	9	8	6–10
	Distance >24.1 km/h (m)	-	19	28	13	22	24	13–28
	Distance >24.1 km/h NR	-	1	2	1	2	2	1–2
	ACC >1 m.s <sup>-2</sup> (m)	-	421	463	502	461	435	421–502
	DEC <-1 m.s <sup>-2</sup> (m)	-	360	405	441	411	378	360–441
	Player load (AU)	-	511	495	582	513	517	495–582
	39	Distance 0–7.9 km/h (m)	-	2167	2148	2012	2054	1606
Distance 8–14.3 km/h (m)		-	1344	1280	1491	1374	1453	1280–1491
Distance 14.4–19.7 km/h (m)		-	466	507	608	532	709	466–709
Distance 19.8–24.9 km/h (m)		-	133	197	182	184	262	133–262
Distance >25 km/h (m)		-	64	69	37	37	64	37–69
Total distance (m)		-	4142	4200	4367	4195	4563	4142–4563
Sprint NR		-	3	6	4	4	6	3–6
Total DEC NR		-	450	432	438	418	430	418–450
DEC NR (>-3 m.s <sup>-2</sup> )		-	12	14	10	14	20	10–20
DEC NR (-2.99–-2 m.s <sup>-2</sup> )		-	39	39	41	40	50	39–50
DEC NR (-1.99–-1 m.s <sup>-2</sup> )		-	135	127	138	120	136	120–138
DEC NR (<-1 m.s <sup>-2</sup> )		-	265	252	248	245	225	225–265
Total ACC NR		-	402	386	392	371	411	371–411
ACC NR (<1 m.s <sup>-2</sup> )		-	207	198	194	191	206	191–207
ACC NR (1–1.99 m.s <sup>-2</sup> )		-	141	131	133	125	143	125–143
ACC NR (2–2.99 m.s <sup>-2</sup> )		-	46	48	42	45	48	42–48
ACC NR (>3 m.s <sup>-2</sup> )		-	9	9	9	10	14	9–14
41		Duration	-	-	-	-	-	-
	Total distance (m)	-	3733–4595	3977–4608	3960–4809	3814–4762	4316–4831	3960–4676
	Distance >14.4 km/h (m)	-	616–666	644–833	689–866	711–895	681–961	695–841
	Distance >18.8–25.2 km/h (m)	-	150–266	162–441	174–204	177–248	177–243	177–207
42	Duration	-	-	-	-	-	-	61–75

(continued)

**Table 5.** (continued)

External Load								
Study	Measures	Goalkeeper	Central defenders	Wide defenders	Central midfielders	Wide midfielders	Forwards/ strikers	Overall team
44	Total distance (m)		4203–6066	4815–6274	4911–6515	4616–6265	4866–5780	4714–6182
	Distance >19.8 km/h (m)		75–190	137–237	161–271	179–293	184–303	146–243
	Total distances (m)	-	2725–5463	2737–5633	2842–5829	2668–5726	2397–5408	2397–5829
	Distance >19.8 km/h (m)		43–217	65–371	25–171	50–190	46–264	25–371
	Distance >25.2 km/h (m)		6–53	13–105	0–18	8–28	6–41	0–105
	ACC NR (>3 m.s <sup>-2</sup> )		54–158	67–167	55–195	55–127	38–115	38–195
	DEC NR (>-3 m.s <sup>-2</sup> )		43–151	65–157	59–180	53–120	36–112	36–157
20	Duration	-	22–86	20–87	21–86	15–86	24–86	15–87
	Total distance (m)		3572–7680	3689–7681	3821–7713	3301–7137	3441–7198	3301–7713
	Distance >19 km/h (m)		49–178	111–391	69–256	89–313	43–255	43–391
49	Total distance (m)	-	3016–5754	3234–6717	3867–7490	3743–7284	2827–6046	2827–7490
	Distance 21.6–25.2 km/h (m)		7–95	23–109	35–148	26–123	2–95	2–148
	Distance >25.2 km/h (m)		0–44	1–49	1–63	3–43	1–3	0–63
<b>Reference values</b>	<b>Total Distance (m)</b>	-	<b>2725–7680</b>	<b>2737–7681</b>	<b>2842–7713</b>	<b>2668–7237</b>	<b>2397–7198</b>	<b>2397–7713</b>
	<b>Distance &gt; 14 km/h (m)</b>		<b>616–666</b>	<b>644–833</b>	<b>689–866</b>	<b>711–895</b>	<b>681–961</b>	<b>616–961</b>
	<b>Distance &gt; 18 km/h (m)</b>		<b>7–266</b>	<b>65–441</b>	<b>25–271</b>	<b>50–313</b>	<b>46–303</b>	<b>7–441</b>
	<b>Distance &gt; 24 km/h (m)</b>		<b>0–64</b>	<b>1–69</b>	<b>0–63</b>	<b>2–43</b>	<b>1–64</b>	<b>0–69</b>
	<b>ACC (&gt;3 m.s<sup>-2</sup>) (NR)</b>		<b>9–158</b>	<b>9–167</b>	<b>9–195</b>	<b>10–127</b>	<b>14–115</b>	<b>9–195</b>
	<b>DEC (&lt;-3 m.s<sup>-2</sup>) (NR)</b>		<b>12–151</b>	<b>14–157</b>	<b>10–180</b>	<b>14–120</b>	<b>20–112</b>	<b>10–180</b>
	<b>Player Load (AU)</b>		<b>511</b>	<b>495</b>	<b>582</b>	<b>513</b>	<b>517</b>	<b>495–582</b>
<b>Internal Load</b>								
32	HR max >90% (min)	-	5	4	8	6	3	3–8
35	s-RPE (AU)	308 ± 150	227 ± 141	249 ± 150	326 ± 165	252 ± 151	232 ± 152	227–326
39	Heart Rate 50–59.9% (min)	-	32 ± 16	38 ± 13	40 ± 16	39 ± 11	44 ± 18	32–44
	Heart Rate 60–81.9% (min)		80 ± 15	96 ± 12	78 ± 12	82 ± 12	88 ± 6	78–96
	Heart Rate 82–89.9% (min)		36 ± 10	28 ± 8	30 ± 10	33 ± 10	35 ± 6	28–36
	Heart Rate 90–94.9% (min)		27 ± 11	12 ± 7	14 ± 7	9 ± 5	2 ± 1	2–27
	Heart Rate 95–100% (min)		4 ± 3	2 ± 2	3 ± 4	1 ± 1	0.03 ± 0.06	0–4
41	s-RPE (AU)	-	251–339	270–384	262–337	216–322	289–364	258–327
42	s-RPE (AU)	-	262–407	292–413	255–374	255–374	271–409	259–350
20	s-RPE (AU)	-	-	39–348	32–320	47–404	24–412	24–401

(continued)

Table 5. (continued)

External Load								
Study	Measures	Goalkeeper	Central defenders	Wide defenders	Central midfielders	Wide midfielders	Forwards/ strikers	Overall team
<sup>49</sup>	s-RPE (AU)	-	220–721	39–657	32–759	47–784	203–765	24–784
<b>Reference values</b>	<b>s-RPE (AU)</b>	<b>308</b>	<b>220–721</b>	<b>249–657</b>	<b>255–759</b>	<b>216–784</b>	<b>24–765</b>	<b>175–784</b>

min: minutes; ACC: acceleration; DEC: deceleration; HR: heart rate; NR: number; ND: non described; HSR: high-speed running distance; HMLD: high metabolic load distance; AU: arbitrary units; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; MPEv: mean metabolic power of high intensity actions; HML: high metabolic load; HMLD: high metabolic load distance.

concern regarding this variable because there were several significant differences on different MDs—namely, MD-4: between WD versus all positions;<sup>44</sup> MD-3: between CB versus WD<sup>20</sup> and WD versus all positions;<sup>44</sup> MD-2 between CD versus WD, CD versus WM, WD versus ST,<sup>20</sup> and WD versus all positions;<sup>44</sup> and MD-1 between CD versus WD and WD versus ST<sup>20</sup>

For sprint distance, CD reported the lowest values among all positions during matches<sup>32</sup> across six weeks.<sup>49</sup> On the other hand, WD covered more distance than other positions during the in-season and on MD-4 and MD-3.<sup>44</sup> WM also covered significantly higher values than the other positions. These results should be highlighted because it allows the WD and WM to successfully perform their actions in the game, such as overlapping, to a greater extent than other positions.<sup>58</sup>

Regarding accelerations and decelerations, WD and CM presented the highest numbers, while the remaining positions remained similar. Moreover, CM presented the highest player load (582 au), while the remaining positions presented a range value between 495–517 au.

Concerning the amounts of the players' ACC and DEC, ST performed significantly more DEC from  $>3 \text{ m.s}^{-2}$  in training sessions than all positions.<sup>39</sup> The ST and CM showed the highest values for DEC from  $-2.99$  to  $-2 \text{ m.s}^{-2}$  compared to all positions in training sessions, while the DEC values from  $-1.99$  to  $-1 \text{ m.s}^{-2}$  were significantly lower only in WM.

Concerning ACC, no significant differences were found by Ispyrilidis et al.,<sup>39</sup> while Martín-García et al.<sup>44</sup> showed that WD produced more ACC than ST on MD-1 and more DEC than CD and ST on MD-4, MD-2, and MD-1. These results are in line with previous findings and emphasise out as requirements of some tactical positions regarding the eccentric mode of their muscle contractions.<sup>59</sup>

We advise researchers to better contextualise the intensity of each training day and the official match in the future so that coaches and technical teams can know the precise sources of intensity each day. For example, in the study by Martín-García et al.,<sup>44</sup> 70% of accelerations on MD-3 were produced by small-sided games.

Regarding the amount of the players' ACC, Castilho et al.<sup>33</sup> found higher values on MD-4 and MD-3 when

compared with MD-1. Similarly, Malone et al.<sup>43</sup> found the highest values for DEC on MD-3 for GK, and Stevens et al.<sup>54</sup> showed higher values for ACC and DEC on MD-4 than on MD-1. These results seem to indicate that coaches use a specific strategy on days further away from the matches (i.e. MD-5 to MD-3), with a focus on more high-intensity short-term actions.<sup>33</sup>

Some context variables have been shown to influence the number of ACC and DEC. Gonçalves et al.<sup>36</sup> showed higher values on MD-1 during weeks before away matches than weeks before home matches. They also observed reduced values on MD-5 during weeks before playing in away matches.

Considering match result, players presented higher DEC values on MD-1 before winning matches than before draws or losses. On MD-3, the results showed higher ACC values before winning matches than before draws. Finally, on MD-5, lower ACC and DEC values were reported before winning matches than before draws or losses.<sup>36</sup>

Concerning player load, the results follow the ACC and DEC values,<sup>32,33</sup> adding that these training sessions can be called strength sessions.<sup>32</sup> Clemente et al.<sup>34</sup> reported that training sessions can be maintained at a high intensity and have low values of player load—for this, it is necessary to decrease the training volume while maintaining the intensity. Malone et al.<sup>43</sup> reported that GK had the highest values on MD-3.

The s-RPE was the internal intensity variable that was most often measured. The highest value was reported by CM (759 AU), while the lowest was reported by ST (24 AU).

Kelly et al.<sup>41</sup> reported that s-RPE was higher in the early season than the mid-season across all positions and that s-RPE was lower for WM than WD on MD-3. Meanwhile, ST showed higher values on MD-2 compared with WM and on MD-1 compared with CM and MD-1 than all positions. In another study, WD and CM obtained lower values than WM in s-RPE over six weeks.<sup>49</sup> Similarly, Clemente et al.<sup>35</sup> reported several significant differences between player positions (including GK). GK showed higher values than CD, WD, WM, and ST; WD had higher values than CD, CM, and ST; CD reported

**Table 6.** Results for external training load by match-day minus (MD-)

External Load								
Study	Contextual variable and measures	MD + 1	MD + 2	MD-5	MD-4	MD-3	MD-2	MD-1
32	Duration (min)	-	-	76 ± 16	86 ± 8	-	81 ± 12	60 ± 11
	Total Distance (m)			4925 ± 1312	6234 ± 1368		5287 ± 1363	3493 ± 1324
	Distance < 10.8 km/h (m)			3691 ± 989	4568 ± 1030		3975 ± 1027	2829 ± 1000
	Distance >20.9 km/h (m)			44 ± 160	190 ± 165		141 ± 165	23 ± 162
	Distance >20.9 km/h NR			5 ± 9	14 ± 10		11 ± 10	3 ± 10
	Distance >24.1 km/h (m)			7 ± 50	46 ± 51		28 ± 51	6 ± 50
	Distance >24.1 km/h NR			1 ± 3	3 ± 3		2 ± 3	0 ± 3
	ACC >1 m.s <sup>-2</sup> (m)			473 ± 134	574 ± 138		469 ± 138	310 ± 134
	DEC <1 m.s <sup>-2</sup> (m)			417 ± 92	501 ± 87		411 ± 78	269 ± 72
	Player load (AU)			536 ± 161	622 ± 168		543 ± 167	392 ± 162
33	Duration (min-max)	-	-	-	75-90	75-90	-	50-70
	Total distance				5873-7047	6068-7281		3065-4291
	Distance >14 km/h				758-909	698-837		410-574
	Distance >21 km/h				420-504	263-315		190-266
	ACC NR (>3 m.s <sup>-2</sup> )				8-9	8-10		3-4
	Player load (AU)				645-774	638-765		330-462
34	Duration (min)	ND	ND	ND	ND	ND	ND	ND
	Total Distance (m)	6023 ± 1691	6277 ± 1423	7063 ± 1461	6077 ± 1055	6920 ± 1846	5702 ± 1273	4585 ± 153
	Distance 0-6.9 km/h (m)	2853 ± 700	2742 ± 316	3067 ± 718	2995 ± 357	3553 ± 1158	3063 ± 592	2720 ± 679
	Distance 7-13.9 km/h (m)	2501 ± 885	2825 ± 1082	2615 ± 720	2382 ± 899	2497 ± 494	1860 ± 550	1379 ± 555
	Distance 14-20 km/h (m)	514 ± 229	573 ± 372	990 ± 360	523 ± 182	623 ± 269	532 ± 279	343 ± 172
	Distance > 20 km/h (m)	156 ± 84	138 ± 118	391 ± 259	177 ± 82	247 ± 240	246 ± 200	143 ± 117
	Maximal Speed km/h (m)	27 ± 3	26 ± 4	30 ± 2	27 ± 3	29 ± 8	28 ± 6	27 ± 3

(continued)

Table 6. (continued)

External Load									
Study	Contextual variable and measures	MD + 1	MD + 2	MD-5	MD-4	MD-3	MD-2	MD-1	
43	Goalkeeper			-	-				
	Duration (mean)	58 ± 20				85 ± 26	83 ± 32	81 ± 29	68 ± 17
	Total distance (m)	2553 ± 1016				3688 ± 1356	3742 ± 1281	3580 ± 1520	2925 ± 839
	ACC NR (>3 m.s <sup>-2</sup> )	5 ± 7				12 ± 9	9 ± 6	9 ± 8	9 ± 5
	DEC NR (<3 m.s <sup>-2</sup> )	4 ± 4				7 ± 5	7 ± 4	5 ± 3	4 ± 3
	Player load (AU)	282 ± 78				380 ± 148	403 ± 162	372 ± 149	328 ± 76
44	Player Status	Non-starter	Starter	-	-				
	Duration (mean)	~75	~68			~77	~83	~80	~61
	Total distances (m)	5226 ± 790	3827 ± 169			5123 ± 905	5603 ± 1206	4221 ± 620	2675 ± 602
	Distance >19.8 km/h (m)	107 ± 104	125 ± 123			246 ± 149	218 ± 119	87 ± 74	50 ± 57
	Distance >25.2 km/h (m)	26 ± 44	21 ± 37			56 ± 60	34 ± 38	12 ± 28	8 ± 18
	ACC NR (>3 m.s <sup>2</sup> )	144 ± 54	66 ± 46			128 ± 37	119 ± 44	104 ± 37	59 ± 22
45	DEC NR (<-3 m.s <sup>2</sup> )	137 ± 49	61 ± 44			115 ± 33	108 ± 41	99 ± 37	57 ± 21
	Total distance (m)	2821 ± 376		-	-	3638 ± 698	3353 ± 431	2827 ± 465	2960 ± 516
	HMLD (>25.5 W.kg <sup>-1</sup> ) (m)	219 ± 106				246 ± 66	208 ± 41	166 ± 39	182 ± 46
	HML NR (>25.5 W.kg <sup>-1</sup> )	18 ± 10				22 ± 8	20 ± 5	15 ± 6	18 ± 7
	ACC NR (>3 m.s <sup>2</sup> )	44 ± 9				60 ± 19	53 ± 29	40 ± 14	47 ± 12
	DEC NR (<-3 m.s <sup>2</sup> )	43 ± 11				53 ± 15	49 ± 25	37 ± 10	41 ± 12
	Impacts NR	192 ± 64				258 ± 103	251 ± 117	194 ± 56	191 ± 117
	Dynamic stress load (AU)	90 ± 35				130 ± 39	104 ± 48	82 ± 26	100 ± 42
46	I-Match Week			-	-				
	Total distance (m)	-				6689–8409	5388–6795	4024–6709	2735–2778
	Distance 0–10.9 km/h (m)					4560–4856	3617–4603	3007–4803	2412–2452
	Distance 11–13.9 km/h (m)					1025–1342	1007–1082	429–837	176–186
	Distance 14–18.9 km/h (m)					789–820	563–790	423–765	118–120
	Distance 19–23.9 km/h (m)					243–285	163–251	134–255	17–34
	Distance >24 km/h (m)					87–107	31–68	25–39	3–4

(continued)

**Table 6.** (continued)

External Load								
Study	Contextual variable and measures	MD + 1	MD + 2	MD-5	MD-4	MD-3	MD-2	MD-1
46	2-Matches Week	-	-	-				
	Total distance (m)				7232–7532	4863–6584	5324–6181	3912–3991
	Distance 0–10.9 km/h (m)				4904–5646	3711–4506	3847–4515	2910–3193
	Distance 11–13.9 km/h (m)				893–1106	871–980	640–877	406–527
	Distance 14–18.9 km/h (m)				628–733	300–780	537–710	289–344
	Distance 19–23.9 km/h (m)				329–398	50–238	151–224	85–95
46	Distance >24 km/h (m)				48–90	14–72	25–90	32–37
	3-Matches Week	-			-			-
	Total distance (m)		5856 ± 247	4428 ± 319		6692 ± 690	3620 ± 357	
	Distance 0–10.9 km/h (m)		4361 ± 221	3470 ± 188		4520 ± 442	2995 ± 200	
	Distance 11–13.9 km/h (m)		643 ± 117	446 ± 96		942 ± 264	290 ± 86	
	Distance 14–18.9 km/h (m)		617 ± 145	404 ± 153		901 ± 177	255 ± 98	
20	Distance 19–23.9 km/h (m)		207 ± 57	98 ± 45		281 ± 120	70 ± 33	
	Distance >24 km/h (m)		33 ± 20	7 ± 4		50 ± 32	13 ± 9	
	Duration (mean)	20	-	80	74	73	73	86
47	Total distance (m)	4577 ± 185		7482 ± 173	5944 ± 105	6206 ± 106	5405 ± 59	3565 ± 56
	Distance >19 km/h (m)	118 ± 18		275 ± 26	249 ± 16	220 ± 14	190 ± 11	72 ± 6
	Data according to Win match	Starter	Non-starter					
47	Duration (mean)	21	17	56	81	80	78	85
	Total distance (m)	4407 ± 295	4491 ± 491	7006 ± 149	6468 ± 90	6724 ± 102	5649 ± 58	3629 ± 57
	Distance >19 km/h (m)	111 ± 34	113 ± 71	279 ± 21	291 ± 18	241 ± 16	216 ± 11	86 ± 7
47	Data according to Draw match	Starter	Non-starter	-				
	Duration (mean)	15	15	30	82	78	69	95
	Total distance (m)	4397 ± 213	4432 ± 483	7112 ± 99	6375 ± 83	6700 ± 13	5577 ± 138	3391 ± 153
	Distance >19 km/h (m)	97 ± 27	114 ± 70	284 ± 18	274 ± 15	233 ± 22	160 ± 19	131 ± 18

(continued)

Table 6. (continued)

External Load									
Study	Contextual variable and measures	MD + 1		MD + 2	MD-5	MD-4	MD-3	MD-2	MD-1
47	Data according to Defeat match	Starter	Non-starter	-					
	Duration (mean)	17	17		65	79	76	88	92
	Total distance (m)	4378 ± 329	4314 ± 677		7326 ± 83	6187 ± 110	7109 ± 142	6109 ± 89	3236 ± 114
	Distance >19 km/h (m)	69 ± 24	118 ± 77		295 ± 25	240 ± 14	307 ± 15	226 ± 16	55 ± 7
48	Data according to home match	Starter	Non-starter	-					
	Duration (mean)	22	31		57	81	81	78	86
	Total distance (m)	4216 ± 259	4650 ± 679		7051 ± 168	6156 ± 95	6644 ± 112	5672 ± 67	3645 ± 62
	Distance >19 km/h (m)	66 ± 30	140 ± 113		254 ± 19	252 ± 18	236 ± 13	203 ± 10	70 ± 7
48	Data according to Away match	Starter	Non-starter	-					
	Duration (mean)	17	16		8	77	79	79	83
	Total distance (m)	4436 ± 342	4261 ± 145		7211 ± 120	6520 ± 124	6864 ± 66	5772 ± 58	3452 ± 67
	Distance >19 km/h (m)	75 ± 40	84 ± 59		316 ± 28	273 ± 17	239 ± 16	208 ± 12	68 ± 5
49	Total distance (m)	-		-	-	5593-6016	5682-7490	5317-6064	2827-3868
	Distance 21.6-25.2 km/h (m)					62-91	95-148	71-96	2-35
	Distance >25.2 km/h (m)					3-16	1-49	3-28	0-3
	Duration (mean)	-		-	-	88 ± 11	82 ± 7	77 ± 12	59 ± 7
54	Total distances (m)					7267 ± 913	6120 ± 1188	5219 ± 881	3848 ± 454
	Distance 14.4-19.8 km/h (m)					834 ± 199	692 ± 219	510 ± 156	328 ± 101
	Distance >19.8 km/h (m)					249 ± 85	281 ± 134	175 ± 108	106 ± 53
	ACC NR (1.5-3 m.s <sup>-2</sup> )					131 ± 31	82 ± 25	81 ± 21	55 ± 13
	ACC NR (>3 m.s <sup>-2</sup> )					66 ± 18	44 ± 13	45 ± 15	26 ± 8
	DEC NR (1.5-3 m.s <sup>-2</sup> )					98 ± 23	64 ± 18	65 ± 17	44 ± 10
	DEC NR (< -3 m.s <sup>-2</sup> )					49 ± 16	30 ± 11	29 ± 11	23 ± 8
	Metabolic power (m)					1363 ± 266	1066 ± 335	854 ± 242	565 ± 124

(continued)

Table 6. (continued)

External Load								
Study	Contextual variable and measures	MD + 1	MD + 2	MD-5	MD-4	MD-3	MD-2	MD-1
<b>Reference Values</b>	<b>Total Distance (m)</b>	<b>2553–6023</b>	<b>5856–6277</b>	<b>4428–7482</b>	<b>3688–7267</b>	<b>3353–7281</b>	<b>2827–6181</b>	<b>2675–4585</b>
	<b>Distance &gt; 14 km/h (m)</b>	<b>670</b>	<b>711–857</b>	<b>509–1381</b>	<b>700–1212</b>	<b>757–1232</b>	<b>582–1020</b>	<b>138–840</b>
	<b>Distance &gt; 18 km/h (m)</b>	<b>66–183</b>	<b>156–240</b>	<b>105–391</b>	<b>190–504</b>	<b>233–837</b>	<b>173–1059</b>	<b>20–266</b>
	<b>Distance &gt; 24 km/h (m)</b>	<b>21–27</b>	<b>33</b>	<b>7</b>	<b>3–107</b>	<b>1–72</b>	<b>3–90</b>	<b>0–37</b>
	<b>ACC (&gt;3 m.s<sup>-2</sup>) (NR)</b>	<b>5–144</b>	-	-	<b>8–128</b>	<b>8–119</b>	<b>9–104</b>	<b>3–59</b>
	<b>DEC (&lt; -3 m.s<sup>-2</sup>) (NR)</b>	<b>4–137</b>	-	-	<b>7–115</b>	<b>9–108</b>	<b>5–99</b>	<b>4–57</b>
	<b>Player Load (AU)</b>	<b>282</b>	-	-	<b>380–774</b>	<b>403–765</b>	<b>372–543</b>	<b>328–462</b>
36	Home Match	Non-extractable data						
	Total Distance (m)							
	Distance < 18 km/h							
	Distance > 18 km/h							
	ACC >2 m.s <sup>-2</sup> (m)							
	DEC <-2 m.s <sup>-2</sup> (m)							
	Player load (AU)							
<b>Internal Load</b>								
32	Heart Rate maximal >90% (min)	-	-	7 ± 7	7 ± 8	-	4 ± 5	3 ± 5
43	Goalkeeper s-RPE (AU)	-	-	322 ± 153	319 ± 143	334 ± 178	286 ± 128	243 ± 83
46	1-match Week RPE (AU)	-	-	-	3.4–3.7	3.7–5.4	3.9–4.8	2.2 ± 1
	s-RPE (AU)				171–227	241–412	301–432	169–184
46	2-matches Week RPE (AU)	-	-	-	2.9–3.5	2.8–4.8	4.3–4.5	2.5–2.9
	s-RPE (AU)				199–208	168–388	321–330	188–273
46	3-matches Week RPE (AU)	-	3.6 ± 0.3	2.6 ± 0.3	-	3.6 ± 0.3	2.8 ± 0.3	-
	s-RPE (AU)		316 ± 96	241 ± 91		273 ± 71	246 ± 79	
20	s-RPE (AU)	34 ± 4	-	332 ± 27	334 ± 26	342 ± 25	274 ± 23	212 ± 16

(continued)

**Table 6.** (continued)

External Load								
Study	Contextual variable and measures	MD + 1	MD + 2	MD-5	MD-4	MD-3	MD-2	MD-1
47	Data according to Win match	Starters	Non-starter	-				
	s-RPE (AU)	40 ± 25	26 ± 12	171 ± 9	361 ± 27	376 ± 26	311 ± 23	214 ± 14
47	Data according to Draw match	Starters	Non-starter	-				
	s-RPE (AU)	29 ± 12	35 ± 8	70 ± 5	404 ± 31	366 ± 24	223 ± 15	211 ± 16
47	Data according to Defeat match	Starters	Non-starter	-				
	s-RPE (AU)	32 ± 23	33 ± 11	243 ± 25	361 ± 27	361 ± 26	340 ± 20	207 ± 26
48	Data according to Home match	Starters	Non-starter	-				
	s-RPE (AU)	46 ± 32	122 ± 151	191 ± 24	355 ± 26	392 ± 23	309 ± 23	219 ± 16
48	Data according to Away match	Starters	Non-starter	-				
	s-RPE (AU)	29 ± 12	23 ± 10	181 ± 19	338 ± 28	368 ± 31	320 ± 23	221 ± 13
49	s-RPE (AU)	-	-	493–571	656–784	338–389	174–222	
54	Heart Rate maximal >90% (min)			17 ± 10	4 ± 6	4 ± 5	3 ± 4	
<b>Reference values</b>	<b>s-RPE (AU)</b>	<b>23–122</b>	<b>316</b>	<b>70–332</b>	<b>171–493</b>	<b>168–784</b>	<b>223–432</b>	<b>169–273</b>
53	s-RPE (AU)	Non-extractable data						

min: minutes; ACC: acceleration; DEC: deceleration; HR: heart rate; NR: number; ND: non described; HSR: high-speed running distance; HMLD: high metabolic load distance; AU: arbitrary units; RPE: rated perceived exertion; s-RPE: session rated perceived exertion; MPEv: mean metabolic power of high intensity actions; HML: high metabolic load; HMLD: high metabolic load distance.

smaller values than CM and WM; and CM had smaller values than WM but higher values than ST. Thus, GK and CM had the greatest perceptions of s-RPE.<sup>35</sup>

Normally, GK spend more training time than other players performing high-intensity exercises,<sup>35</sup> which can lead to severe fatigue—both central (psychological) and peripheral (muscular). Thus, they influence the response in RPE and, consequently, s-RPE. CM generally covered a greater total distance than other positions,<sup>60</sup> which may contribute to a greater perceived effort in matches and training sessions.<sup>35</sup> ST's and WM's work rate is generally characterised by sudden bursts of high-intensity activity,<sup>49</sup> usually to provide frontal support or perform breaking movements in the opponent's defense by sprinting. On the other hand, no significant differences were found between positions in the pre-season, in-season, and MDs.<sup>20,42</sup>

### Training intensity by players' status

This systematic review discovered some studies that analysed player status (starters vs. non-starters),<sup>44,45,47,48</sup> highlighting the importance of differentiating the day after the match (MD + 1) between starters and non-starters.

Oliveira et al.<sup>48</sup> showed longer durations of training sessions after the game (MD + 1) for starters (20.6 min) compared to non-starters (16.6 min) after the team won the game; no major differences were observed after draws or losses. Oliveira et al.<sup>48</sup> did not reveal any significant difference between starters and non-starters in terms of total distance, duration of training sessions, sprint distance (above 19 km/h), or s-RPE. However, the results revealed that after home matches, non-starters trained longer than starters (31 vs. 22 min). Non-starters also had higher s-RPE values than starters (122.4 vs. 46.1 AU) and longer distances covered while sprinting (139.7 vs. 66.5 m). However, such differences did not occur after away matches. This result suggests that match location influences the training session after a game, as they are easier to plan when the teams do not have to travel.

Martín-García et al.<sup>44</sup> revealed higher values for ACC, DEC, and total distance covered among non-starters than starters on MD + 1. This session tends to be composed of a reduced number of players, which results in a specific approach to small-sided games (e.g. increased numbers of touches, dribbles, and duels). However, these exercises do not increase sprinting. Therefore, these authors suggest that training on MD + 1 should combine small-sided games and running-based exercises to provide the necessary stimuli needed to decrease the differences between starters and non-starters.

Moreno-Pérez et al.<sup>45</sup> showed that intensity was reduced from MD-4 to MD-1 to ensure maximum recovery and performance during matches. During the study period, significant differences emerged between starters and non-starters

in terms of total distance covered. In this sense, the data suggest the need to develop training drills that increase the volume of running distance and high-metabolic intensity efforts while reducing the frequency of ACC and DEC.

### Training intensity by the match-day minus (Md-) approach

Concerning the MD- approach, this systematic review provides new guidelines for organising the training intensity during the week before (MD-) and after (MD + 1, MD + 2) an official match. Therefore, considering MD + 1, MD + 2, and MD-5 to MD-1, the results indicate lower external intensity on MD + 1 and MD-1 and higher values from MD + 2 to MD-3, with a decrease on MD-2. However, only three studies considered player status on MD + 1.<sup>44,47,48</sup> In addition, studies presented different training schedules and days off, which could influence the results (this is why we present all seven days of the week).

Several studies have reported higher external or internal intensities on days further away from a match day, specifically, on MD-5;<sup>34</sup> MD-4,<sup>32,44,54</sup> and MD-3.<sup>33,43,49</sup> Conversely, the lowest values were presented on MD-1 in most studies.<sup>32,44,48,49,54</sup> This training intensity reduction on the day before the match could be associated with the tapering period, which decreases fatigue and promotes recovery to increase athletes' performance in the upcoming match.<sup>61</sup>

Regarding total distance, some studies reported the highest values on MD-5 and the lowest on MD-1.<sup>20,54</sup> Similarly, Clemente et al.<sup>34</sup> showed high total distances covered on MD-5 and MD-3, while Owen et al.<sup>49</sup> presented high values on MD-3. Some studies also presented significant differences between MD-1 and all other days.<sup>20,46-49,54</sup> Two studies analysed data from GKs and revealed that the highest values for total distance occurred on MD-4 (3638 m)<sup>45</sup> and MD-3 (2553–3742 m).<sup>43</sup> Both studies showed the lowest values on MD-1.

Some studies have tried to verify the influence of contextual variables on intensity distribution throughout the week. Oliveira et al.<sup>46</sup> verified whether the number of games per week (i.e. 1–3) affected the intensity distribution during the microcycle. The results showed that in weeks with one match, the highest values occurred on MD-2 and MD-4, while MD-1 had the lowest values. In weeks with two matches, the highest values occurred on MD-4, while the lowest values occurred on MD-1. In weeks with three matches, the highest values occurred on MD-2 (which was also the day after the previous match), and MD-1 showed the lowest values (there was no day off in this microcycle). In another study, Oliveira et al.<sup>47</sup> tried to verify whether the result of the match influenced the intensity distribution throughout the week. Their results revealed that players covered greater distances on MD-3 and MD-2

after a loss than after a draw or win; on MD-1, the greatest values were obtained after a win. This result must be considered to optimise athletes' performances in matches.

Finally, two studies showed that the location of the match influences the distribution of the weekly intensity before the match.<sup>36,48</sup> MD-5 showed higher values for home and away matches;<sup>48</sup> however, lower values were found during the weeks before away matches. Regarding MD-4, the results of the two studies are also inconsistent. Oliveira et al.<sup>48</sup> exhibited higher values when an away match was approaching, while Gonçalves et al.<sup>36</sup> observed greater total distances during weeks before home matches. Oliveira et al.'s<sup>48</sup> work was the only study to exhibit higher values when an away match was approaching on MD-3 and MD-2 and that total distance was lower on MD + 1 after an away match. Meanwhile, Gonçalves et al.'s<sup>36</sup> study was the only one to report a greater total distance on MD-1 on weeks before away matches than before home matches. Based on these results, coaches should consider increasing the focus on tactical issues one day before away matches (i.e. specific match situations).<sup>36</sup> However, these two studies complement each other and reinforce the idea that future studies should utilise this approach.

Considering the distances covered at different high-intensity running speeds, distances at >14.39 km/h presented a similar pattern as total distance. However, only the value of ~670 m was obtained for MD + 1.<sup>34</sup> This could be associated with the different training schedules adopted by different researchers, as some did not use MD + 1 to describe the day after the match (i.e. MD + 1 was a day off). The highest values of the microcycle were reported from MD + 2 to MD-4, while the intensity was the lowest on MD-2 and MD-1. Distances at >18 km/h presented the highest values on MD-3 and MD-2, while the lowest value was found on MD-1. Distances at >24 km/h showed similar values throughout the microcycle, with the highest values found between MD-4 and MD-2 and the lowest values found on MD + 1, MD + 2, and MD-1.

ACC and DEC showed similar values throughout the microcycle, except on MD-1, on which the lowest values were recorded. Player load showed the lowest value on MD + 1 in only one study with a GK.<sup>43</sup> Again, the different weekly schedules could justify the results. Similar values were found from MD-4 to MD-2, and the lowest values were found on MD-1.

Concerning internal intensity, s-RPE followed a similar pattern as other external intensity variables. Low values were found from MD + 1 to MD-5 and on MD-1. High intensities were reported on MD-4 and MD-3, with the intensity being reduced until the match day.<sup>20,32,43,46-49</sup>

Additionally, Stevens et al.<sup>54</sup> showed that players spent little time above 90% HRmax on MD-3, MD-2, and MD-1 (3-4 min) when compared with MD-4 (17 min). These results suggest that the last three days of the week involve limited aerobic conditioning. However, this variable was

underexplored in the studies included in the present systematic review compared to s-RPE.

Regarding s-RPE, Springham et al.<sup>53</sup> recorded the highest value on MD-4 in weeks with one match. Other studies reported the highest value on MD-3 and revealed a decreasing tendency until MD-1.<sup>20,49</sup> Malone et al.<sup>43</sup> confirmed these results, but only among GK. However, Oliveira et al.<sup>46</sup> reported the highest s-RPE values on MD-2 in weeks with one match. This result was different when the team had two games in one week, as the highest value occurred on MD-3. Furthermore, in weeks with three games, the day after the game exhibited the highest value, while no differences were found between the other days. Thus, the results suggest that there is no linear pattern in the different types of microcycles. It is likely that MD-1 is the only training session with a focus on the strategy for the upcoming match, thus reporting lower values. There also seems to be some consensus regarding the reduced values on MD + 1.<sup>20,47,49</sup>

Regarding the influence of context variables, MD-5 showed differences before all match scores (wins, losses) but smaller for draws, and on MD-2, s-RPE was greater before losses than before wins and draws.<sup>47</sup> This may happen because the coach may plan training sessions with completely different objectives depending on the previous result, which may increase or decrease homeostasis disturbances.<sup>62</sup> When preceding home matches versus away matches, s-RPE was lower on MD-5 when closer to an away match than a home match. Meanwhile, MD-2 reported higher values closer to an away match than a home match, and MD + 1 showed lower values after playing an away match than a home match.<sup>48</sup>

These results support the idea that the coach organised recovery sessions on the day after the match. Gonçalves et al.<sup>36</sup> added that on MD-4, the s-RPE was higher during the weeks before home matches than away matches and that s-RPE was higher on MD-1 during weeks before an away match than before a home match. When analysing the opponent's level, it was found that s-RPE was higher on MD-3, MD-2, and MD-1 during weeks prior to matches against low-ranked opponents than opponents of a medium level.<sup>36</sup>

Regarding the duration of training sessions, Oliveira et al.<sup>20</sup> reported the highest values on MD-5 and MD-1, and Stevens et al.<sup>54</sup> recorded the highest value on MD-4. However, Oliveira et al.<sup>47</sup> showed that contextual variables influenced the duration of training sessions. Training sessions were longer on MD-5 and MD-2 after defeats than after wins or draws, on MD-1 after draws than after defeats or wins, and on MD + 1 after wins than after draws or defeats.<sup>47</sup> Oliveira et al.<sup>48</sup> added that training sessions were longer on MD-1 when closer to a home match than an away match. Meanwhile, on MD + 1, training sessions were lower after playing an away match than a home match. These results suggest that duration should

progressively decrease throughout the week (MD-5 to MD-1) so that players do not manifest any signal of fatigue on MD.<sup>48</sup>

### Study limitations and strengths

This study presents some limitations that should be addressed. The small number of studies including absolute measures for internal training intensity shows that more research is needed. Moreover, few studies analysed contextual variables such as player status, match results, match location, or opponents' level. In addition, different training schedules were presented, which makes it difficult to provide precise reference values. Nevertheless, the present study provided such range intervals.

Moreover, the reviewed studies came from different competition levels and countries, which constitutes significant differences in context. This lack of uniformity in classifying speed and acceleration thresholds limits comparisons between studies, thus making it difficult to generalise their results.

Despite these limitations, the present study constitutes a relevant tool in the field of training intensity quantification among professional male soccer players that can be used by coaches, their staff, and practitioners as a reference for future studies. For instance, the several speed thresholds allowed other coaches or researchers to replicate such range intervals for their own training sessions for the overall team. It was confirmed that days in the middle of the week displayed higher intensity values and that the day before the match displayed the lowest intensity values for all measures. Therefore, coaches can better periodise training sessions regarding these specificities.

Future research should consider properly identifying which kinds of training exercises make better use of the values provided by each study.

### Practical applications

Since official matches are the most important session in a week, training sessions should be designed to improve performance and minimise injury risk. Considering this aim and using match demands as a primary basis, coaches should manage training volume and intensity throughout the week. During MD + 1, coaches should program recovery strategies that accelerate homeostasis processes. In this sense, coaches have used low-intensity running programs, although the effects of such a recovery strategy are unclear.<sup>63</sup> Training load should then slightly increase progressively until MD-3 before facilitating recovery from MD-3 to MD so that players enter the match in the best physical, physiological, and psychological state possible. However, the use of training individualisation strategies should be considered, for example, by utilising training intensity quantification and prescription per

playing position. In this sense, coaches should consider that WD and ST covered more distance, CD covered less high-intensity running distances, and CM performed more short-intensity actions.

### Conclusions

This study provided reference values for the most commonly used measures of external and internal intensity in absolute values. Considering the overall team values, the main speed thresholds were as follows: >14 km/h, 410–1884 m; >18.8 km/h, 7–541 m; and >24 km/h, 3–190 m. The number of ACC and DEC from >3 m.s<sup>-2</sup> consisted of 3–195 and 10–157, respectively, while player load ranged from 310–774 AU. The s-RPE range was 26–936 AU.

The positions with higher intensity levels (distance >14 km/h) were the wide midfielders and strikers, while defenders presented the lowest values. Central midfielders displayed the highest values for ACC, DEC, and player load. Wide midfielders presented the highest values of s-RPE, while defenders presented the lowest values. The days of the week with the highest intensities were MD-5, MD-4, and MD-3. A decrease in intensity was reported until MD-1 for all variables.

Together, the values presented in this study constitute possible reference values that can be used by coaches, their staff, or practitioners to achieve desirable competitive levels. They allow coaches to replicate such values or even increase them during training sessions.


### Declaration of Conflicting Interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. GQ3


### Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Fundação para a Ciência e a Tecnologia, (grant number UIDP/04748/2020). AQ1

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