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Are physiological, physical, wellness and load decisive markers of starting players? A case study from a professional male soccer team

Rafael Oliveira[1,2,3,*], Rui Canário-Lemos[4,5], Ryland Morgans[6], Tiago Rafael-Moreira[5,7], José Vilaça-Alves[3,4,5], João Paulo Brito[1,2,3]

[1]Santarém Polytechnic University, School of Sport, 2040-413 Rio Maior, Portugal
[2]Life Quality Research Centre (CIEQV), Santarém Polytechnic University, 2040-413 Santarém, Portugal
[3]Research Center in Sport Sciences, Health Sciences and Human Development (CIDESD), Santarém Polytechnic University, 2040-413 Rio Maior, Portugal
[4]University of Trás-os-Montes e Alto Douro, 5001-801 Vila Real, Portugal
[5]Research Group in Strength Training and Fitness Activities, GEETFAA, 5001-801 Vila Real, Portugal
[6]School of Sport and Health Sciences, Cardiff Metropolitan University, CF23 6XD Cardiff, UK
[7]Research Center of the Polytechnic Institute of Maia (N2i), Maia Polytechnic Institute (IPMAIA), 4475-690 Maia, Portugal

***Correspondence**
rafaeloliveira@esdrm.ipsantarem.pt
(Rafael Oliveira)

Abstract

The study aim was to compare physiological, physical, accumulated wellness and load markers within a European professional soccer team between starters and non-starters. Ten starters (age: 25.1 ± 2.2 years; experience: 7.3 ± 2.3 years) and eight non-starters (age: 26.1 ± 4.6; years' experience: 8.3 ± 4.1 years) participated in the study. The study was conducted across 20 weeks where 75 training sessions and 15 matches occurred. Wellness (fatigue, quality of sleep, muscle soreness, stress and mood) and load (rating of perceived exertion (RPE), accelerations, decelerations, high-speed running and sprinting) measures were observed. Physiological evaluation consisted of a 1200 m maximum effort shuttle test while physical capacity assessment included isokinetic strength, jump ability and balance tests. Isokinetic tests were used to assess peak torque of both legs (extension and flexion at 60°/s and 180°/s), single squat jump and single hop jump were utilized to assess jump ability and Y-balance tests were employed to examine balance. Starters presented significantly higher values for peak torque extension of the non-dominant leg compared to non-starters ($p = 0.038$, effect size (ES) = 0.996), while non-starters showed higher values for both Y-balance postero-medial and postero-lateral ($p = 0.009$, ES = −1.309 and $p = 0.021$, ES = −1.133, respectively). Accumulated duration and RPE were lower for non-starters than starters ($p \leq 0.001$, ES = 1.268, and $p = 0.022$, ES = 1.123, respectively). The physiological and physical tests conducted in this study do not seem to determine the starting status of players, considering that only one test revealed significantly higher values for starters. Despite the lower training and match duration for non-starters, this showed that it is possible to accumulate identical load while managing wellness regardless of starting status.

Keywords

Athletes; Exercise test; External Load; Football; Internal load; Muscle strength; Wellbeing

1. Introduction

The status of a player (*i.e.*, starter versus non-starter) has been considered as an important contextual factor in soccer, although there is scant research that compares training load [1]. Recently, it was found that earlier in the season, higher values for starters over non-starters occurred when using acute: chronic workload ratios (ACWR calculated through player load) [2, 3], arguably a flawed analysis as the chronic values may be represented by the off-season period. In contrast, no differences were observed between starters and non-starters when examining the ACWR of key metrics (rating of perceived exertion (RPE), total distance and high-speed running distance (HSR)) across 10 months of the in-season [4]. Regarding external training load measures without additional calculations (*i.e.*, ACWR), as expected greater values for non-starters were reported in training sessions performed one day after the match (*e.g.*, match day plus one) for total distance, HSR and sprinting [5]. A more recent study reported higher accumulated weekly loads of total distance and sprint distance for starters compared to non-starters [3]. Furthermore, when analyzing wellness measures (sleep, fatigue, muscle soreness and stress), starters presented higher values across the in-season (using training monotony, strain and ACWR calculations) [6], thus supporting previous studies [2, 3].

The monitoring of load, wellness and readiness across the season have become an integral part of performance monitoring aimed at improving individualized training prescription. While load and wellness considering playing status have previously been reported, there are scarce information investigating readiness and playing status. The concept of monitoring readiness may include several objective markers such as submaximal, and maximal physical tests. Furthermore, a combination of wellness and readiness may provide more precise knowledge on the training status of an athlete [7]. Several physical tests have gained interest recently that can provide detailed information to support player programming. Maximal Aerobic Speed (MAS) is one test that has been widely accepted in various sports due to its field-based testing environment and simplicity to test large groups of athletes. Previously, improvements in youth soccer player's aerobic fitness has been shown to correlate with the time spent above MAS [8]. For instance, these authors showed a correlation (r = 0.90) between velocity at VO_2 max (VO_2 max is the maximum rate (V) of oxygen (O_2) your body can utilize during exercise) and MAS [8]. Another important assessment is athlete balance. Previously, one study highlighted the relevance of postural stability and its association with injury prevention strategies [9]. Thus, it seems relevant to periodically assess balance (starting in the pre-season before official competition) for an improved physical capacity overview or as part of returning to match-play criteria following injury [9, 10]. The Y-Balance Test (YBT) is an easily applicable test and has been shown to be valid and reliable to predict future lower limb injuries [9, 10]. Assessing muscle strength, specifically knee flexors and extensors, is common practice in soccer with the isokinetic dynamometry considered one of the most reliable tests [11, 12]. Considering that sprinting and jumping are depending on the knee joint, recent research has analyzed such associations [12]. This type of analysis will determine lower limb strength and simultaneously, may help develop a more effective training program and load management to improve speed and agility skills and consequently reduce injury risk [12].

A recent study conducted in professional female soccer players comparing physical, physiological, body composition, and load measures reported that the only significant difference found between starters and non-starters was body composition [13]. While no other soccer research is available, a study in amateur handball compared regional versus national category level players and found better cardiovascular capacity, repeated sprint ability and change of direction in the national players but no difference in jump ability [14]. Despite contrasting findings when comparing different levels of player rather than starting status, it would be expected that those who played more (starters) would present higher levels of physical capacity.

Therefore, the aim of the present study was to compare physiological, physical, accumulated wellness and load markers of starters and non-starters from a European professional soccer team. The study hypothesis was that starters will display higher physical, physiological, and accumulated load and lower wellness due to higher match minutes exposure when compared to non-starting players.

2. Materials and methods

2.1 Design

This was a cross-sectional case study design with data from 20 weeks. At the beginning of pre-season, participants completed physiological and physical tests following the normal monitoring procedures of the club. Additionally, participants were monitored daily for wellness, and load (internal and external) during 75 training units, six home and nine away official matches during the 2022/23 season (July to November).

2.2 Participants

A convenience sample of 18 professional male soccer players (age: 25.5 ± 3.4 years; body-mass: 72.5 ± 7.9 kg; height: 179.6 ± 7.9 cm; body-fat: 8.8 ± 1.2%; professional playing experience: 7.7 ± 3.2 years) participated in the study. Players participated in the national first division from a European league. From the total players included, seven were defenders, six were midfielders and five were attackers. The small sample size of the present research is common in previous studies [6, 13, 15] which presented a similar number of participants.

The inclusion criteria were: (i) participating in all physical and physiological assessments and; (ii) completed all wellness and internal training logs (RPE) over the data collection period. Players with lower participation training rates were still included as this study intended to test possible differences according to player participation in training and matches.

Moreover, playing status was defined either as starter that completed a minimum of 60-minutes in three consecutive matches or non-starter for all other players who did not achieve three consecutive match participation [6, 13]. Consequently, this study included 10 starters (age: 25.1 ± 2.2 years; body mass: 73.4 ± 8.7 kg; body height: 180.7 ± 9.0 cm; body mass index: 22.4 ± 1.0; fat mass: 8.7 ± 1.1%; professional experience: 7.3 ± 2.3 years) and eight non-starters (age: 26.1 ± 4.6 years; body mass: 71.5 ± 7.1 kg; body height: 178.1 ± 6.5 cm; body mass index: 22.5 ± 1.1; fat mass: 8.7 ± 1.5%; professional experience: 8.3 ± 4.1 years). Considering training sessions and matches, starters were absent 6.5 ± 7.7%, while non-starters were absent 14.9 ± 16.4% of training and match time.

All data resulted from normal analytical procedures regarding player monitoring over the competitive season.

2.3 Data collection

All tests were applied over two consecutive days by the same researcher who has over three years of expertise in this field. On day one, height, body mass, and fat mass were assessed before the ingestion of their normal breakfast. Physical tests were then applied: vertical and horizontal jump tests; Y-Balance; and Isokinetic test (recovery time was provided between each test). On day two, the physiological assessment of the 1200 m maximum effort shuttle test was performed. All tests were performed in an ambient temperature between 22 to 23 °C and relative humidity between 50 to 60%. Before any physiological or physical test, a standardized warm-up consisting of low-to-moderate running and dynamic stretching of the lower limbs was performed. Finally, considering the unilateral physical assessments, the dominant leg was self-selected and classified when striking a ball with the highest possible strength and accuracy [16].

2.3.1 Body mass, height and fat mass

Body mass, height and fat mass were collected following previous collection procedures [13]. Specifically, all tests were performed in the morning (between 7:30 and 8:30 AM) following a minimum of 8-hour of fasting and players' emptying their bladders. Prior to these assessments, the participants were instructed to refrain from exercise, ingesting alcohol, or caffeine during the previous 12 hours. Participants wore light clothes and no shoes. A stadiometer with an incorporated scale (Seca 220, Hamburg, Germany) was utilized to assess height and body mass. Fat mass was gathered using the Inbody S10 (model JMW140, Biospace Co, Ltd., Seoul, Korea).

2.3.2 Physical assessments

The single leg squat jump (SJ) adapted from previous research [17] was applied to assess vertical jump capability. The SJ began in a squat position (knee flexed to 90°) with hands fixed on the waist. Following a verbal instruction, players jumped as high as possible with straight leg and plantar flexion during flight. A maximum of three efforts were completed, interspersed with 60-second of recovery [18]. The best result in centimeters was recorded for statistical analysis. A commercially available platform was utilized to measure the SJ (Chronojump) [17], which was connected to the Chronopic® hardware (Chronojump Boscosystem, Barcelona, Spain) to obtain jump height data.

The single leg broad jump (SLBJ) was applied to assess horizontal jump capability. The SLBJ began in a standing position in a unilateral stance with the tested leg fully extended, the alternate leg flexed to 90° at the hip and knee joints, and hands were fixed at the waist. Participants completed a self-selected countermovement, followed by a forward jump as far as possible, landing on the same leg. Participants had to maintain hands on the hips during the jump. Prior to the jump, it was prohibited to swing. This test has previously shown good absolute reliability with 3.65 to 9.81% of the coefficient of variation in basketball players [19]. Three repetitions were completed for each leg, interspersed with a recovery period of 60-seconds. The longest jump in centimeters was recorded for further analysis.

Functional balance was assessed utilizing the Y-balance test. Following test familiarization, and prior to testing, the measurement of both lower limb lengths was conducted as previously documented [16, 20]. All participants performed this test without footwear to reduce variability and ensure stability in foot placement. The established YBT Kit (Perform-Better, West Warwick, Rhode Island) was employed to assess participants. This equipment comprised of three connected cylindrical tubular plastic bars marked in half cm increments. These bars can be easily adjusted to the indicator plate, to allow the participant to move with the appropriate body-part (foot/toe) [21]. According to the lower quarter YBT protocol [21], each participant was informed of the test procedure that included; (a) to stand on a single leg in the middle of the platform with the toe just behind the red line, (b) from this start position, perform three efforts with the free limb in the anterior direction (AN), postero-medial direction (PM) and postero-lateral direction (PL). Test-retest reliability (intraclass correlation coefficients) have previously been reported and ranged between 0.85 to 0.93 (across the three positions) [22, 23]. To standardize the assessment procedure and as a key indicator of test completion, participants were instructed to fix and remain hands on the waist throughout the test. This procedure was repeated on each side, right and left. An effort was not considered valid if the participant: (a) removed hands from the hips; (b) changed the position of the supporting foot during the test; (c) allowed the free foot to touch the ground; (d) lost balance during the test; and (e) did not maintain the initial position for at least one second in the end of the test [9]. If an unsuccessful effort was performed, the participant returned to the start position and the test was repeated. If a successful effort was completed, the measure was recorded when the participant fully returned to the start position [21].

Finally, the seated leg extension/curl exercise tests were conducted to assess peak torque at 60°/s and 180°/s velocity using the isokinetic equipment Computer Sports Medicine, Inc., (CSMi) HUMAC2015®/NORM™ (HUMAC NORM, Stoughton, MA, USA). The tests were performed on the right and left side of the body, consistently starting with the dominant leg and all values corresponded to concentric contractions. Moreover, thigh belts were positioned on the thorax and abdomen as well as above the knee (of the evaluated side) to limit trunk and knee movements during the test. Players were instructed to flex and extend the knee "as hard as possible". To reduce the learning effect of isokinetic muscle testing, the assessment protocol commenced with a familiarization session immediately followed by the test session. A randomized trials order was applied, and each set was followed by 2 to 5 minutes of rest to prevent cumulative fatigue. During each trial, strong verbal encouragement was provided. In accordance with the manufacturer's guidelines, the isokinetic equipment was calibrated prior to every test session.

2.3.3 Physiological assessment

During the pre-season period, to determine VO_2 max, participants completed a 1200 m shuttle MAS test [22, 23]. This test has previously been validated against varying MAS protocols [24, 25]. Markers were positioned at the start, and at 20 m, 40 m and 60 m. The previously documented protocol was followed [22, 23] where participants were positioned at the start point and were instructed to run to the 20 m mark and back to the start, 40 m mark and back to the start, 60 m point and back to the starting position. This course was performed five times maximally to complete 1200 m [25]. Verbal encouragement was provided ensuring player motivation while performing maximally at 1-minute intervals [26]. As a result of the selected MAS test protocol included change of direction, the following corrective equation was employed to calculate MAS: 1200/(Time − 20.3-s (0.7-s for each turn) = MAS (m/s)) [24].

2.4 Wellness, internal and external monitoring

All collected measures were analyzed in accumulated values from all weeks which included training sessions and matches.

2.4.1 Wellness quantification

Thirty minutes prior to any training session or match, a specific google form that has been previously validated to assess wellness [27] was completed. Five categories related to fatigue, quality of sleep, muscle soreness, stress and mood (the scoring scale of 1–5 arbitrary units (AU) was as follows: "5 = very fresh, very restful, very great, very relaxed and very positive mood, respectively, while 1 = always tired, insomnia, very sore, highly stressed and highly annoyed/irritable/down", respectively [27]) were evaluated. All participants were familiar with the questionnaire format due to implementation in previous season.

2.4.2 Internal load quantification

Following 20- to 30 minutes post-training and matches, the CR-10 Borg's scale [28] was conducted to collect internal load through RPE. Similarly to the wellness quantification, the google form was used to collect individual data by answering "how intense was the session?". This scale ranged from 0 to 10 AU, in which: "0 = nothing; 0.5 = extremely weak; 1 = very weak; 2 = weak; 3 = moderate; 4 = somewhat strong; 5 = strong; 7 = very strong; and 10 = extremely strong". Then, session-RPE was calculated by each session duration multiplied by the RPE [29, 30]. All participants were familiar with the questionnaire format due to implementation in the previous season.

2.4.3 External load quantification

Thirty minutes prior to any training session or match, a 10 Hz global positioning system unit Vector S7 (Catapult Innovations, Melbourne, Australia) that has previously provided good validity and reliability for the majority of distance and threshold-based accelerations and decelerations [31]. All data collection procedures and unit error and reliability have previously been reported [15, 32, 33]. The pod was situated in a specifically designed vest located on the upper back of the players and removed immediately post-session/match to collect external load measures. The same unit was used for each player during the 20-week period to avoid any inter-unit bias. Following every training session and match, data were extracted using (version 1.21.1 of Catapult Openfield software, Melbourne, Australia) and exported to a secure database for analysis, as software-derived data is a more simple and efficient way for practitioners to obtain data in an applied environment, with no differences reported between processing methods (software-derived to raw processed) [34]. The external load metrics selected for analysis were: HSR (20–25 km/h) and sprinting (>25 km/h) [35], number of accelerations (ACC, >2 m/s^2) and number of decelerations (DEC, <2 m/s^2) [36].

2.5 Statistical analysis

The IBM SPSS Statistics for Windows (version 23.0, IBM Corp, Armonk, NY, USA) was used for all descriptive and inferential statistics. Mean ± standard deviation and 95% confidence intervals (CI) were used for descriptive statistics. All measures were tested for normality and homogeneity using the Shapiro-wilk and Levene tests, respectively. Normal distribution was not confirmed for the absence percentage of the players, peak torque extension of the right leg (180°), duration and RPE ($p < 0.05$). Thus, non-parametric Mann-Whitney U test was used for those variables while the parametric independent t-test was used for the remaining measures to compare the different status of the players.

A $p < 0.05$ was considered as a significant result. Furthermore, the effect magnitude Hedges effect-size (ES) was determined (by the difference of two means divided by the standard deviation of the different measures). Finally, the ES was interpreted as follows: <0.2 = trivial, 0.2 to 0.6 = small effect, 0.6 to 1.2 = moderate effect, 1.2 to 2.0 = large effect, and >2.0 = very large [37].

3. Results

The anthropometric and body composition characteristics of both groups reported no significant differences (all, $p > 0.05$) for height (starters, 180.7 ± 9.0 cm; non-starters, 178.0 ± 6.3 cm), for body mass (starters, 73.4 ± 8.7 kg; non-starters, 71.4 ± 7.2 kg) and for body-fat (starters, 8.7 ± 1.1%; non-starters, 8.9 ± 1.5%).

Regarding the absence percentage of participants, there were no significant differences between groups ($p = 0.206$). Table 1 presents the comparisons of physical and physiological variables for starters and non-starters. Only extension peak torque of the non-dominant leg was significant higher with moderate effect for starters. Moreover, YBT-postero-medial (YBT-PM) and YBT-postero-lateral (YBT-PL) of non-dominant legs were significant higher with moderate ES for non-starters. No other differences were found.

Table 2 presents the comparisons of load and wellness measures for starters and non-starters. Only duration and RPE were significant higher with moderate and large ES, respectively, for starters compared to non-starters while no other differences were found.

4. Discussion

The purpose of the present study was to compare physiological, physical, accumulated wellness and load markers of starters and non-starters from a European professional soccer team. The main finding reported higher values for non-starters in the postero-medial and postero-lateral YBT while no other differences were displayed. In addition, accumulated values (which include both training sessions and matches) for duration and RPE were higher in starters than non-starters. However, the remaining external load and wellness measures did not reveal any significant differences. The small number of participants may contribute to the non-significant results. Although, this reflects the real-world environment of elite professional soccer. Notwithstanding the foregoing, a recent study conducted in professional female soccer players reported scarce significant differences between starters and non-starters when examining physical, physiological, body composition, and load measures [13]. Thus, it can be speculated that physical and physiological measures may be utilized to determine the playing status in this specific cohort [38]. Thereafter, with the increasing number of official matches and evolution of training methods, in which coaches have a crucial role [39],

TABLE 1. Comparisons of physical and physiological variables considering playing status.

Measures	Starters (n = 10) Mean ± SD (95% CI)	Non-starters (n = 8) Mean ± SD (95% CI)	*p*	Effect size
Ext peak torque DL, 60°/s (N.m)	238.6 ± 36.7 (213.9–263.3)	212.4 ± 28.0 (188.9–235.8)	0.109	0.75
Ext peak torque NDL, 60°/s (N.m)	230.0 ± 33.5 (207.5–252.5)	199.8 ± 21.0 (182.2–217.3)	**0.038**	1.00
Ext peak torque DL, 180°/s (N.m)	171.6 ± 25.5 (154.5–188.8)	159.0 ± 21.9 (140.7–177.3)	0.275	0.50
Ext peak torque NDL, 180°/s (N.m)	161.7 ± 23.5 (145.9–177.5)	158.8 ± 19.8 (142.2–185.3)	0.775	0.13
Flexion peak torque DL, 60°/s (N.m)	136.6 ± 26.3 (119.0–154.3)	132.5 ± 20.0 (115.7–149.3)	0.714	0.17
Flexion peak torque NDL, 60°/s (N.m)	129.9 ± 20.3 (116.3–143.6)	135.1 ± 19.4 (118.9–151.4)	0.581	−0.25
Flexion peak torque DL, 180°/s (N.m)	116.1 ± 18.1 (103.9–128.2)	102.6 ± 11.9 (92.7–112.6)	0.085	0.81
Flexion peak torque NDL, 180°/s (N.m)	103.7 ± 8.9 (97.8–109.7)	100.8 ± 11.8 (90.9–110.6)	0.537	0.28
Squat jump DL (%)	23.2 ± 3.1 (21.1–25.3)	23.6 ± 2.3 (21.7–25.5)	0.761	−0.14
Squat jump NDL (%)	23.9 ± 3.7 (21.4–36.4)	24.2 ± 3.5 (21.3–27.2)	0.851	−0.09
Single hop DL (%)	172.3 ± 17.1 (160.8–183.7)	168.9 ± 13.2 (157.8–179.9)	0.644	0.21
Single hop NDL (%)	174.4 ± 18.8 (161.8–187.0)	175.8 ±11.8 (165.9–185.6)	0.857	−0.08
YBT-AN DL (%)	63.1 ± 4.9 (59.8–66.4)	58.7 ± 7.7 (52.2–61.2)	0.146	0.68
YBT-AN NDL (%)	63.3 ± 4.4 (60.3–66.2)	60.5 ± 7.3 (54.4–66.6)	0.315	0.46
YBT-PM DL (%)	109.6 ± 12.6 (101.2–118.1)	119.7 ± 13.1 (108.7–130.7)	0.110	−0.75
YBT-PM NDL (%)	113.5 ± 13.6 (104.4–122.7)	132.8 ± 14.7 (120.5–145.1)	**0.009**	−1.31
YBT-PL DL (%)	107.3 ± 12.4 (99.0–115.6)	115.9 ± 7.9 (109.3–122.5)	0.101	−0.77
YBT-PL NDL (%)	108.6 ± 9.9 (102.0–115.3)	119.1 ± 7.1 (113.2–125.1)	**0.021**	−1.13
MAS (m/s)	4.3 ± 0.2 (4.1–4.4)	4.2 ± 0.2 (4.1–4.4)	0.848	0.09

SD, standard deviation; CI, confidence interval; Ext, extension; DL, dominant leg; NDL, non-dominant leg; YBT, Y-balance test; AN, anterior; PM, postero-medial; PL, postero-lateral; MAS, maximal aerobic speed; bold denotes significant results (p < 0.05).

TABLE 2. Comparison of load and wellness variables considering playing status.

Measures	Starters (n = 10)	Non-starters (n = 8)	*p*	Effect size
Duration (min)	4980.5 ± 1087.8 (4249.6–5711.3)	3674.4 ± 813.2 (2994.5–4354.3)	<**0.001**	1.27
RPE (AU)	575.5 ±75.8 (524.6–626.5)	473.3 ± 95.3 (396.5–556.0)	**0.022**	1.12
HSR (m)	16,700.9 ± 4646.7 (13,579.2–19,822.6)	13,508.4 ± 4592.5 (9668.9–17,347.8)	0.156	0.66
Total sprint distance (m)	3808. 4 ± 1246.4 (2971.1–4645.8)	3497.5 ± 1246.4 (2132.8–4862.2)	0.643	0.21
Acceleration (nr)	4634.2 ± 750.8 (4129.8–5138.5)	3869.0 ± 1018.1 (3017.8–4720.2)	0.076	0.84
Deceleration (nr)	4288.9 ± 635.8 (3861.8–4716.1)	3621.8 ± 876.4 (2889.1–4354.4)	0.071	0.86
Quality of sleep (AU)	392.3 ± 51.4 (357.7–426.8)	359.9 ± 80.6 (292.5–427.3)	0.310	0.48
Fatigue (AU)	338.5 ± 52.7 (303.1–373.9)	350.4 ± 90.9 (274.3–426.4)	0.746	−0.16
DOMS (AU)	334.1 ± 50.0 (300.5–367.7)	337.8 ± 84.2 (267.4–408.1)	0.907	−0.05
Stress (AU)	369.2 ± 60.1 (328.8–409.6)	337.9 ± 86.0 (266.0–409.8)	0.362	0.42
Mood (AU)	376.5 ± 52.7 (341.1–412.0)	337.8 ± 89.5 (262.9–412.6)	0.251	0.53

RPE, rating of perceived exertion; HSR, high-speed running distance; DOMS, muscle soreness; AU, arbitrary units; bold denotes significant results (p < 0.05).

highly prepared (physically, physiologically, technically and tactically) players are expected [40].

Regarding the evaluation of dynamic balance to determine an athlete's injury risk or sport readiness, it has been well documented that several factors such as sex, movement ability, range of motion, proprioception, and strength [41] can contribute to this ability. For that reason, in support of the present study hypothesis, it would be expected that some differences would be evident. However, the opposite occurred. Previous research showed improvements in strength of professional players [42] and differences in match load quantification considering the competitive level [43], although, the present study showed higher values for non-starters in postero-medial and postero-lateral YBT while no significant differences were reported in isokinetic and jump tests and external load variables. These findings are even more relevant considering that this study included players with varying participation levels, where absence was evident due to injuries and starters presented higher values, possibly due to more accumulated training and match duration, although not significant. Thus, injury status can not be justified with the current results.

Considering soccer actions regularly include accelerating and decelerating to overcome inertia, the ability to develop greater relative (in relation to an athlete's body mass) lower body strength may be essential during soccer training and match-play. However, the present findings did not differentiate between players with varying body fat measures. Notwithstanding, body composition of players should be carefully monitored, specifically for non-starters [44]. Moreover, MAS was also identical for both groups which contrasts previous research in youth soccer players that suggested aerobic capacity can be highly associated with match-play participation [45].

Although some determinants for success (performance-level) in soccer performance such as isokinetic strength, reactive strength, power, change of direction speed, reactive agility, dynamic balance, and functional symmetry are well established, the level of players will allow the determination of which capacities may be considered crucial for higher performance in soccer [46]. Thus, constant load monitoring is relevant to progressively improve physical performance and avoid greater injury risk in soccer players. Consequently, it may allow a better training approach and adjustment considering the principle of individuality [47].

When examining load and wellness quantification, no differences were found between starters and non-starters except for RPE, which was higher for starters. From training load analysis, the main differences are normally related to the day following match-play, where starters have a lower load due to the previous match participation. This notion is also supported by previous research [5] that showed higher values in external load measures during this specific day. However, contrasting findings regarding session-RPE were reported in previous studies that showed higher values for starting than non-starting players following a successful match outcome (win) and lower values after drawing or losing [48]. Furthermore, higher running metrics of total distance and HSR and RPE were observed following a home match and lower running metrics and RPE after an away match, with the exception of average speed which was reversed [49]. Although, caution must be considered when interpretating these results, as contextual variables were not considered across the 15 examined matches and if divided according to match outcome and location, for further analysis, this would decrease the sample power. Still, other studies also supported higher values for starters than non-starters across the season [2, 3, 50], although different calculations were employed. The same scenario for starters revealed higher values for wellness measures was evident. However, some justifications may be associated with higher match participation and consequently accumulated duration [6].

From a physiological perspective, RPE is a psychophysiological marker [28], although RPE findings from the present study were not supported by the MAS findings, as no differences between groups were noted. Therefore, other tactical/technical contextual variables such as shots, passes, occupied space, and ball control, may be more important to determine the playing status (starter versus non-starter) [38]. This has also been recently suggested that found no significant differences in the majority of measures, included RPE and session-RPE in starters versus non-starters [14]. Still, it is relevant to highlight that this study [14] analyzed relative data (all values were divided by minutes) while the present research used absolute data.

Some limitations of this study should be acknowledge: (a) even though previous research included similar number of participants [6, 13, 15], as only one team was examined, a limited sample of players were available in which the minimum sample power or statistical power was not achieved, thus restricting the generalization of the results; (b) only 20 weeks from the full-season were analyzed; (c) only one time point of assessment was examined while further test data points would strengthen the analysis; (d) from the 18 participants, only 10 were already familiarized with all physical and physiological assessments from the previous season while eight players were only familiarized in the testing day; (e) some physical assessments were adapted and not validated in soccer players (*e.g.*, single leg SJ, SLBJ, YBT), and (f) match outcome and location were not considered for analysis due to the small number of matches (n = 15). Therefore, further studies are warranted for confirmation of the present results a greater number of participants, a longitudinal period (entire full-season), more time-points of assessments, while including contextual, tactical, and technical variables should be considered in future analysis.

5. Conclusions

The current research did not confirm the hypothesis that starters would display higher physical, physiological, accumulated load and lower wellness compared to non-starters. In fact, the opposite was found when considering postero-medial and postero-lateral YBT, where greater values for non-starters were found.

In addition, only accumulated data for duration and RPE were higher for starters than non-starters, while the remaining measures were similar regardless of starting status. Moreover, this study highlighted that physical, physiological, load and wellness values can be identical regarding playing status.

Finally, this study highlights the context of each data analysis which means that the lack of significant findings may be associated with the low number of athletes and their context of competition level.

AVAILABILITY OF DATA AND MATERIALS

Due to issues of participant consent related to the new data protection law from 25 May 2018 from the Portuguese data protection law nº. 58/2019 of 8 August, in accordance with the Council and European Parliament (EU) Regulation 2016/679, 27 April 2016, on the protection of individuals regarding the processing of personal data and on the free movement of such data, data will not be shared publicly. Interested researchers may contact the corresponding author.

AUTHOR CONTRIBUTIONS

RO, RCL and JPB—Conceptualization. RO and RCL—methodology; data curation. RCL—data collection. RO—formal analysis. RO, RCL, TRM, JVA, RM and JPB—writing-original draft preparation; writing-review and editing. RO, RM and JPB—supervision. All authors have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All data were anonymised prior to analysis in accordance with the Declaration of Helsinki. Moreover, this study was approved by the local ethics committee of the Polytechnic Institute of Santarém, Santarém, Portugal (No. 24-2022ESDRM, July 2022) and the professional club from which the participants volunteered. Written informed consent was obtained from all participants.

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CONFLICT OF INTEREST

The authors declare no conflict of interest. Rafael Oliveira is serving as one of the Editorial Board members of this journal. We declare that Rafael Oliveira had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to DM.

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