A comparison of match-physical demands between different tactical systems: 1-4-5-1 vs 1-3-5-2

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Abstract

The team tactical system and distribution of the football players on the pitch is considered fundamental in team performance. The present study used time-motion analysis and triaxial-accelerometers to obtain new insights about the impact of different tactical systems (1-4-5-1 and 1-3-5-2) on physical performance, across different playing positions, in a professional football team. Player performance data in fifteen official home matches was collected for analysis. The sample included twenty-two players from five playing positions (centre backs: n = 4; full-back/wide midfielder/wing-back: n = 9; centre midfielder: n = 6 and centre forward: n = 3), making a total of 108 match observations. A novel finding was that general match physical demands do not differ considerably between these tactical formations, probably because match-to-match variability (variation of players’ running profile from match-to-match) might be higher than the differences in physical performance between tactical systems. However, change of formation had a different impact across playing positions, with centre backs playing in 1-4-5-1 performing significant more HIRcounts than in 1-3-5-2 (p = 0.031). Furthermore, a medium effect size (r = 0.33) was observed in HIRdist, with wide players covering higher distances when playing in 1-3-5-2 than in 1-4-5-1. These findings may help coaches to develop individualised training programs to meet the demands of each playing position according to the tactical system adopted.

Introduction

To better understand the constraints correlated with sporting success, match analysis has become an important tool in team sports. Nowadays it is well accepted among coaches and sport scientists that the match performance of a football team is, basically, based on four factors: physical, technical, tactical and mental [1]. Even though, the majority of research has been executed within the physical and technical performance domain, previous studies have
started to establish connections between physiological demands and tactical behaviour in elite football [2–5].

The lack of research and information about this field can be observed in a systematic review (2012–2016) on match analysis in adult male football [6], where the contextual variables of research analysed (match half, quality of opposition, match location, scoring first, group stage vs knockout phase, substitutions, competitive level and different competitions) did not include the tactical systems used by teams.

The team tactical system and the positioning and distribution of the players on the pitch is considered one of the most important strategic decisions in football [5, 7, 8] and, it is evident that player match-load is influenced by different factors, such as the playing position [2, 9, 10] and the tactical system [11]. This highlights the importance of understanding how physical demands may be affected by playing position in various tactical systems [6]. Despite some previous research [12, 13] addressing the team global positioning on the field, using the measures of centre and dispersion, the role of the tactical system regarding the players' physical performance, has not been fully described.

Previous studies have concluded that the manipulation of playing formations in small sided games promotes changes in physical performance of teams and players in training [14]. Also, the success of different tactics and strategies depend on the capacities and abilities of the players to perform specific actions during the match. Consequently, players must fulfil the necessary physiological requirements of their playing position inside the tactical system adopted [5, 15, 16].

Previous research has investigated the influence of opposition tactical formation on physiological performance variables and reported higher running distances when playing against a 1-4-2-3-1 formation compared to a 1-4-4-2 formation [17]. In opposition, other studies [11, 18] using various teams and/or different players across different seasons have concluded that tactical systems do not influence the match activity profiles of players. A pilot study with youth players [19] reported no correlation between physical/technical levels and tactical prominence in football matches. However, the identification of the tactical system adopted by a particular team is not a trivial step and previous studies have subjectively defined the tactical formations analysed by using qualified coaches to identify the different formations, as well as to verify if those formations were consistent throughout the game [17, 20]. To the best of our knowledge, no other study has examined the effect of playing formation on player load by position within the same team, in one full season.

An in-depth analysis of match physical performance across playing positions, in different tactical formations, could provide a better understanding of position-specific demands and provide an useful insight to optimize training programs [11]. Therefore, the present study aimed to analyse how tactical systems affect the physical performance of a professional football team across different playing positions in all official home matches during one season. We hypothesize that, despite playing in their specific position, players will accumulate different external workload in matches, depending on the tactical formation deployed.

**Methods**

**Participants and match analysis**

With institutional ethics approval from UiT The Arctic University of Norway Institutional Review Board, written informed consent from players and approval from the Norwegian Centre for Research Data, data on performance in 15 official home matches from the professional team of a Norwegian elite football club, during one season (2017), was collected for analysis. The matches were all played on artificial grass surface, as described in detail previously [10].
The sample included 22 players (25.2 ± 4.4 years of age; 76.2 ± 6.4 kg of body mass; and, 181.6 ± 5.6 cm of height) across four different playing positions: centre back, CB (n = 4, observations = 37), full-back/wide midfielder/wing-back, FB/WM/WB (n = 9, obs = 31), centre midfielder, CM (n = 6, obs = 26), and centre forward, CF (n = 3, obs = 14), making a total of 139 match observations (Table 1). Playing-positions were chosen according to the two tactical formations used by the team and previous research [9, 21, 22]. Team tactical systems and playing positions were determined by two UEFA-qualified coaches (one from the coaching staff of the team analysed) after visualizing video recordings of the sampled matches [17, 20]. These observers subjectively determined the tactical systems used at the beginning of the match and verified if the formations were consistent throughout the matches [17]. Furthermore, 1-4-5-1 and 1-4-3-3 formations were combined, as well as 1-3-5-2 and 1-5-3-2. This procedure was applied due to difficulties in establishing specific differences between similar playing formations when in attacking and defending. When analysing the 1-3-5-2 formation the observers realized that the team often played in 1-5-3-2 formation when not in ball possession (defending) and in 1-3-5-2 with ball possession (attacking). On the other hand, when observing the 1-4-5-1 formation, the observers concluded that the team played in 1-4-5-1 when defending and in 1-4-3-3 when attacking [11, 17]. No other changes in formations throughout the matches were noticed by the observers, therefore no matches were excluded from the analysis.

Data was analysed only if: (a) players completed the full match (90 minutes), (b) the player played in the same position during all the match and (c) the team used 1-4-5-1 (1 goalkeeper; 2 CB + 2 FB; 3 CM + 2 WM; 1 CF) or 1-3-5-2 (1 goalkeeper; 3 CB; 3 CM + 2 WB; 2 CF) tactical formations during the entire match.

To ensure players confidentiality, all data was anonymized before analyses.

### Procedures

A stationary radio wave-based Local Positioning Measurement (LPM) tracking system (ZXY Sport Tracking System, Trondheim, Norway), with a default resolution of 20Hz, was used to characterize match activity profiles within the team. Each player wore a specially designed belt, wrapped tightly around the waist, with an electronic sensor system at the player’s lumbar spine, as reported previously [10]. At the stadium, where the matches occurred, there are 6 RadioEyes for optimal coverage, resulting in practically zero packet loss for transponders on the field. If packet loss occurred, the data was linearly interpolated. The accuracy and reliability of the system in measuring player movements in elite soccer competitions have been described in more detail in previous studies [23–25].

### Physical performance variables

Physical parameters analysed included: total distance (TotDist) number of accelerations (acc_counts), acceleration distance (acc_dist), number of decelerations (dec_counts), deceleration...
distance (dec_dist), number of HIR (HIR_counts), HIR distance (HIR_dist), number of sprints (sprint_counts), sprint distance (sprint_dist) and turns.

The HIR (≥19.8 km·h⁻¹) and sprinting (≥25.2 km·h⁻¹) speed thresholds are similar to those reported in previous research [10, 22, 24, 26].

According to the ZXY Sport Tracking system accelerations were quantified through numerical derivation from positional data with a sampling frequency of 20Hz [25]. Furthermore, accelerations are defined by four event markers: (a) the start of the acceleration event is marked by the acceleration reaching the minimum limit of 1 m·s⁻², (b) the acceleration reaches the acceleration limit of 2 m·s⁻², (c) the acceleration remains above the 2 m·s⁻² for at least 0.5 seconds and (d) the duration of the acceleration ends when it decreases below the minimum acceleration limit (1 m·s⁻²).

Turns were counted only if the player performed a continuous and significant body rotation of more than 90˚ in one direction (derived from gyroscope and compass data). The end of a turn and the start of another occurs when a rotation in the opposite direction is measured. The angle threshold used by ZXY Sport Tracking system allowed us to analyse only angles ≥90˚.

**Statistical analysis**

The results are presented as mean and 95% confidence interval, unless otherwise stated. A linear mixed-effects model with restricted maximum likelihood estimations was used to examine differences in Local Positioning Measurement-derived variables and match duration between 1-3-5-2 and 1-4-5-1 formations. Mixed models can account for unbalanced repeats per player and thus used to model the data. Tactical formation, playing position and their interaction was modelled as fixed effects (effects describing the association between the dependent variable and covariates), while ‘athlete ID’ was included as a random effect (effects generally representing random deviations from the relationships of the fixed part of the model). An α-level of 0.05 was used as level of significance for statistical comparisons. Furthermore, multiple comparisons were adjusted using the Tukey method. The t statistics from the mixed models were converted to effect size correlations [27]. Effect sizes were interpreted as <0.1, trivial; 0.1–0.3, small; 0.3–0.5, moderate; 0.5–0.7, large; 0.7–0.9, very large; 0.9–0.99, almost perfect; 1.0, perfect [28]. All statistical analyses were conducted using the lme4, lsmeans and psychometric packages in R statistical software (version 3.4.1, R Foundation for Statistical Computing, Vienna, Austria).

**Results**

**Centre-backs**

Slightly higher values, though not statistically significant, were found in HIR_dist, Acc and Dec (counts and distance), sprint_counts and turns when playing in 1-4-5-1 compared to 1-3-5-2 formation (Table 2). Furthermore, CB playing in 1-4-5-1 were observed to perform significant more HIR_counts (36.1 ± 3.5) than in 1-3-5-2 (28.2 ± 3.5) (p = 0.008), with a correspondent medium effect size (r = 0.37).

**Wide positions**

No significant differences were observed between the tactical formations analysed from players playing in wide positions (Table 3). However, higher values in HIR_dist (r = 0.19) and sprint_dist (r = 0.16) were found when playing with 1-3-5-2 (977.2 ± 73.7; 236.9 ± 26.8) compared to 1-4-5-1 (838.9 ± 62.5; 195.3 ± 22.7) formation.
Table 2. Mean and 95% confidence interval estimates of different physical parameters from centre backs, analysed according to the tactical system used, and respective p-value and effect size of differences observed (n = 4; observations = 37).

| Variables | 1-4-5-1 | 1-3-5-2 | p-value | Effect Size (r) |
|-----------|---------|---------|---------|----------------|
| TotDist (m) | 10865.0 (227.6) | 10591.8 (224.0) | 0.825 | 0.15 |
| HIR counts | 36.1 (3.5) | 28.2 (3.5) | 0.008 | 0.37 |
| HIR dist (m) | 512.0 (81.5) | 431.0 (81.3) | 0.658 | 0.18 |
| Sprint counts | 6.6 (1.9) | 5.4 (1.9) | 0.871 | 0.15 |
| Sprint dist (m) | 64.4 (29.6) | 74.2 (29.5) | 0.999 | 0.06 |
| Acc dist (m) | 325.6 (37.6) | 306.9 (37.6) | 0.982 | 0.10 |
| Acc counts | 63.2 (6.1) | 59.7 (6.1) | 0.983 | 0.10 |
| Dec dist (m) | 321.2 (41.7) | 278.5 (41.6) | 0.543 | 0.20 |
| Dec counts | 60.3 (6.9) | 53.6 (6.9) | 0.680 | 0.18 |
| Turns | 32.2 (3.5) | 25.8 (3.4) | 0.437 | 0.21 |

Centre midfields
Small effect sizes were observed in HIR counts (r = 0.12) and Acc counts (r = 0.14) (Table 4), with higher values being observed when playing in 1-4-5-1 (38.5 ± 3.2; 62.3 ± 5.5) than in 1-3-5-2 (35.7 ± 3.4; 55.9 ± 5.9). A similar effect size was also observed in turns (r = 0.15), with CM performing more turns when playing in 1-3-5-2 (40.3 ± 3.7) than in 1-4-5-1 (34.7 ± 3.4).

Centre forwards
No significant differences were found regarding any parameter analysed. However, higher values, though with a trivial effect size, in HIR dist and sprint dist can be observed (Table 5) when playing in 1-3-5-2.

Tactical system
Significant differences were found in various parameters when comparing the physical performance of the whole team when playing with different tactical systems (Table 6). Significant higher values were observed in HIR counts (r = 0.25) and sprint counts (r = 0.22) when playing in...
1-4-5-1 (43.6 ± 1.9; 11.4 ± 1.1) compared with 1-3-5-2 (40.0 ± 2.0; 10.0 ± 1.1) (p = 0.005 and p = 0.015, respectively). Furthermore, when playing in 1-4-5-1, the team was observed to perform more Acc
 counts (75.8 ± 3.2) and Dec
 counts (77.8 ± 3.5), as well as covering higher distances in Dec
 dist (440.3 ± 23.3) than when playing in 1-3-5-2 (71.1 ± 3.4; 72.5 ± 3.6; 413.7 ± 24.2; for Acc
 counts, Dec
 counts and Dec
 dist) (p = 0.022; p = 0.014 and p = 0.032, respectively).

**Discussion**

**Context**

The present study provides new insights into the physical demands of two common tactical formations, in elite football players across different playing positions. The context of this study appeared with the change of the head-coach, and consequently, the tactical formation and style of play used of the professional football team analysed. Since this replacement happened in the middle of the season, both tactical formations analysed were composed by an almost equal number of matches (7 and 8 home matches each). It is also important to refer that the change of head-coach led not only to a simple switch of the tactical structure used, but also to a change to a more complex style of play. A more possession and position-oriented style of play

| Variables | CM | p-value | Effect Size (r) |
|-----------|-----|---------|----------------|
| TotDist   | 12009.0 (218.5) | 11820.8 (238.7) | 1.000 | 0.09 |
| HIR
 counts | 38.5 (3.2) | 35.7 (3.4) | 0.948 | 0.12 |
| HIR
 dist | 643.2 (73.1) | 610.9 (78.1) | 1.000 | 0.06 |
| Sprint
 counts | 7.0 (1.6) | 7.0 (1.7) | 1.000 | 0.05 |
| Sprint
 dist | 101.4 (26.6) | 94.8 (28.4) | 1.000 | 0.03 |
| Acc
 dist | 313.3 (33.4) | 289.6 (35.5) | 0.973 | 0.10 |
| Acc
 counts | 62.3 (5.5) | 55.9 (5.9) | 0.845 | 0.14 |
| Dec
 dist | 358.3 (37.0) | 326.0 (39.4) | 0.923 | 0.13 |
| Dec
 counts | 69.4 (6.2) | 64.2 (6.6) | 0.951 | 0.11 |
| Turns | 34.7 (3.4) | 40.3 (3.7) | 0.782 | 0.15 |

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Table 5. Mean and 95% confidence interval estimates of different physical parameters from centre forwards, analysed according to the tactical system used, and respective p-value and effect size of differences observed (n = 3; observations = 14).

| Variables | CF | p-value | Effect Size (r) |
|-----------|----|---------|----------------|
| TotDist   | 10724.4 (328.6) | 10732.8 (328.6) | 1.000 | >0.01 |
| HIR
 counts | 48.6 (4.7) | 47.1 (4.7) | 1.000 | 0.05 |
| HIR
 dist | 835.2 (108.5) | 930.5 (108.5) | 0.881 | 0.14 |
| Sprint
 counts | 11.7 (2.4) | 12.8 (2.4) | 0.993 | 0.08 |
| Sprint
 dist | 164.5 (39.5) | 208.5 (39.5) | 0.689 | 0.18 |
| Acc
 dist | 483.4 (49.4) | 477.7 (49.4) | 1.000 | 0.02 |
| Acc
 counts | 82.9 (8.2) | 80.2 (8.2) | 1.000 | 0.05 |
| Dec
 dist | 461.4 (54.8) | 470.8 (54.8) | 1.000 | 0.03 |
| Dec
 counts | 78.3 (9.2) | 73.4 (9.2) | 0.992 | 0.09 |
| Turns | 36.8 (5.1) | 29.7 (5.1) | 0.810 | 0.16 |

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were adopted (1-3-5-2) instead of the more direct play and counter-attack strategy used in the first half of the season (1-4-5-1). However, even with all these changes, the context remained the same (same players with similar physical capacities).

**Comparison according to playing position**

The results suggest that general match physical demands do not differ considerably between these two tactical formations when compared by playing position. Independent of formation and with few exceptions, players presented similar profiles in all the physical parameters analysed. The most relevant exceptions were the higher HIR<sub>counts</sub> in CB (1-4-5-1) and longer HIR<sub>dist</sub> in FB/WM/WB (1-3-5-2), with a medium and small effect size, respectively. CB playing in 1-4-5-1 performed more HIR<sub>counts</sub>, probably due to the larger area they needed to cover when compared to the area covered by the three CBs when playing in 1-3-5-2. When in defensive organisation (without ball possession), the defensive line of three CBs became most of the time a defensive line composed by 5 players (three CBs and two WBs). The increased number of players playing in the defensive line leads to less m<sup>2</sup> per player to cover.

Players in wide positions covered more HIR<sub>dist</sub> when playing in 1-3-5-2 most likely because in this formation the team played with only two wide players (WB), and they needed to cover all the flank, while with 1-4-5-1 formation, those flanks were covered by a total of four players (two on each side).

It has been speculated that match physical demands are higher for CF when playing “alone” in the offensive line (e.g. 1-4-5-1; 1-5-4-1), as they are very often isolated and marked by several opponents [29]. However, the results of the present study are slightly different, since higher, though not significant, values were found in HIR<sub>dist</sub> and sprint<sub>dist</sub> for CF, when playing with two attackers (1-3-5-2) compared with playing with only one (1-4-5-1).

Furthermore, no differences in playing time (substitutions) were observed in any playing position between the two tactical systems analysed.

**Comparison according to team workload**

When playing position was not taken into consideration and the work-load of the whole team was analysed, the physical workload in some variables was significantly different between tactical systems used. Small significant differences were observed in HIR<sub>counts</sub> and sprint<sub>counts</sub>, with the team performing more runs (>19.8 km/h) when playing in 1-4-5-1. The number of Acc...
and Dec was also higher when the 1-4-5-1 system was used. In general, almost all variables analysed presented higher values during the first period of the season (1-4-5-1) than in the second (1-3-5-2).

Previous research [30, 31] has suggested that teams who are winning the match tend to relax and decrease their work-rate. Alternatively, although teams who are losing the match may increase their work-rate during a specified period [32, 33], they may quickly lose the motivation to keep the elevated work rate, which may be especially evident when the goal difference increases negatively (conceding more goals) [34]. In fact, the differences observed between these two tactical systems might be, in part, justified by the significant discrepancy between the score line and match final results achieved during the first and second part of the season. While playing in 1-4-5-1 the team achieved one victory, four draws and three defeats in the eight home matches played. On the other hand, while playing in 1-3-5-2, the team had better results, with five victories, one draw and one defeat in the last seven home matches played. The match results (considerably more draws) and the differences in style of play may therefore, partly justify the higher work-rate of the 1-4-5-1 tactical system.

Limitations
Our initial hypothesis was that, despite playing in their specific positions, players would accumulate different external workload in matches, depending on the preferred tactical formation. However, the results presented in this study do not fully support the hypothesis, probably because the match-to-match variability might be larger than the differences in physical performance between tactical systems. Like most of the measures in team sports performance, the physical variables used in this study are not stable and are subject to a high variation between successive matches [35]. Furthermore, it has been proved that within-subject (player) and between-match variation in physical performance across the season might be experienced due to changes in the physical condition of the player [36, 37] and environmental conditions [38]. Previous studies have shown that match-to-match variability in performance characteristics of elite soccer players is high [35, 39, 40] and that future research based in match performance requires large sample sizes to identify true systematic changes in workload. In fact, the sample size (22 players/108 observations) might be of such small numbers that true differences can be masked due to a statistical type 2 error, and such a consequence cannot be conclusively ruled out. Previous similar studies have analysed more matches [17] or used considerably larger sample sizes [11] than in the present study. However, they have not compared the physical demands of different tactical systems within the same players in the same context (same team and season) and to do so, a larger sample size than the one used in the present study becomes a difficult task to fulfil.

Even though, the methodology used to determine the team formations is in line with previous studies [11, 14, 17, 20, 41, 42], the process of defining team formations and controlling their consistency throughout the matches was based on the subjective assessment of observers. Further research is needed to attempt to define objectively team formations and to identify when changes occur [17].

Goalkeepers were not included in the present study, however their match activity profiles might be useful and interesting to analyse in different tactical systems and styles of play in future research. All these limitations should be taken into consideration when designing future studies.

Perspectives and practical application
Since previous research has shown that the players’ physical demands in matches are highly dependent on their positional role in the team [43, 44], analytics, in general, have become a
crucial component of team organization and content of training, to meet the position-specific requirements of physical conditioning [45]. This study goes beyond the individualization of training demands according to playing position, also suggesting that the change of tactical system might influence, specific variables of the team’s overall match activity profile, and those differences should be taken into consideration when designing training programs. On the other hand, differences are not notable in all playing positions and these findings should be interpreted with caution, as differences might be team dependent since other teams using the same tactical systems, probably appear with different styles of play.

Change of formation had a different impact on different playing positions, with CB and wide positions presenting more substantial differences than CM and CF. As previously mentioned, the present study and its findings may provide useful and novel insights for coaches on physical performance demands in different tactical formations across playing positions. The information provided should be taken into consideration when designing and implementing training program cycles, according to players’ playing position, the team’s tactical formation and style of play. The individualization and specialization of the training should, therefore, be a matter of reflection and analysis from practitioners.

Supporting information
S1 File. Data review.
(XLSX)

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References
1. Sarmento H, Marcelino R, Anguera MT, CampaniCo J, Matos N, LeitAo JC. Match analysis in football: a systematic review. J Sports Sci. 2014; 32(20):1831–43. Epub 2014/05/03. https://doi.org/10.1080/02640414.2014.898852 PMID: 24787442.
2. Bloomfield J, Polman R, O’Donoghue P. Physical Demands of Different Positions in FA Premier League Soccer. Journal of sports science & medicine. 2007; 6(1):63–70. Epub 2007/01/01. PMID: 24149226; PubMed Central PMCID: PMC3778701.
3. Drust B, Atkinson G, Reilly T. Future perspectives in the evaluation of the physiological demands of soccer. Sports medicine (Auckland, NZ). 2007; 37(9):783–805. Epub 2007/08/29. https://doi.org/10.2165/00007256-200737090-00003 PMID: 17722949.
4. Moura FA, Martins LE, Anido Rde O, de Barros RM, Cunha SA. Quantitative analysis of Brazilian football players' organisation on the pitch. Sports biomechanics. 2012; 11(1):85–96. Epub 2012/04/24. https://doi.org/10.1080/14763141.2011.637123 PMID: 2251947.

5. Rein R, Memmert D. Big data and tactical analysis in elite soccer: future challenges and opportunities for sports science. SpringerPlus. 2016; 5(1):1410. Epub 2016/09/10. https://doi.org/10.1186/s40064-016-3108-2 PMID: 27610328; PubMed Central PMID: PMCPMC49968605.

6. Sarmento H, Clemente FM, Araujo D, Davids K, McRobert A, Figueiredo A. What Performance Analysts Need to Know About Research Trends in Association Football (2012–2016): A Systematic Review. Sports medicine (Auckland, NZ). 2018; 48(4):799–836. Epub 2017/12/16. https://doi.org/10.1007/s40279-017-0836-6 PMID: 29243038.

7. Kannekens R, Elferink-Gemser MT, Visscher C. Positioning and deciding: key factors for talent development in soccer. Scandinavian Journal of Medicine & Science in Sports. 2011; 21(6):846–52. https://doi.org/10.1111/j.1600-0838.2010.01104.x PMID: 22126715.

8. Sampaio J, Macas V. Measuring tactical behaviour in football. Int J Sports Med. 2012; 33(5):395–401. Epub 2012/03/02. https://doi.org/10.1055/s-0031-1301320 PMID: 22377947.

9. Schuth G, Carr G, Barnes C, Carling C, Bradley PS. Positional interchanges influence the physical and technical match performance variables of elite soccer players. J Sports Sci. 2016; 34(6):501–8. Epub 2015/12/25. https://doi.org/10.1080/02640414.2015.1127402 PMID: 26700131.

10. Baptista I, Johansen D, Seabra A, Pettersen SA. Position specific player load during match-play in a professional football club. PLoS One. 2018; 13(5). https://doi.org/10.1371/journal.pone.0198115 PMID: 29795703; PubMed Central PMID: PMCPMC5967838.

11. Bradley P, Carling C, Archer D, Roberts J, Dodds A, Di Mascio M, et al. The effect of playing formation on high-intensity running and technical profiles in English FA Premier League soccer matches. J Sports Sci. 2011; 29(8):821–30. Epub 2011/04/23. https://doi.org/10.1080/02640414.2011.561868 PMID: 21512949.

12. Bartlett R, Button C, Robins M, Dutt-Mazumder A, Kennedy G. Analysing Team Coordination Patterns from Player Movement Trajectories in Soccer: Methodological Considerations. International Journal of Performance Analysis in Sport International Journal of Performance Analysis in Sport. 2017; 12 (2):396–424.

13. Moura FA, Martins LE, Anido RO, Ruffino PR, Barros RM, Cunha SA. A spectral analysis of team dynamics and tactics in Brazilian football. J Sports Sci. 2013; 31(14):1568–77. Epub 2013/05/02. https://doi.org/10.1080/02640414.2013.799920 PMID: 23631771.

14. Baptista J, Travassos B, Goncalves B, Mourao P, Viana JL, Sampaio J. Exploring the effects of playing formations on tactical behaviour and external workload during football small-sided games. J Strength Cond Res. 2018. Epub 2018/01/18. https://doi.org/10.1519/JSC.0000000000002445 PMID: 29337830.

15. Clemente FM, Couceiro MS, Martins FM, Ivanova MO, Mendes R. Activity profiles of soccer players during the 2010 world cup. J Hum Kinet. 2013; 38:201–11. Epub 2013/11/16. https://doi.org/10.2478/hukin-2013-0060 PMID: 24275995; PubMed Central PMID: PMCPMC3827759.

16. Silva JR, Magalhaes J, Ascensao A, Seabra AF, Rebelo AN. Training status and match activity of professional soccer players throughout a season. J Strength Cond Res. 2013; 27(1):20–30. Epub 2012/02/22. https://doi.org/10.1519/JSC.0b013e31824e1946 PMID: 22344051.

17. Carling C. Influence of opposition team formation on physical and skill-related performance in a professional soccer team. European Journal of Sport Science. 2011; 11(3):155–64. https://doi.org/10.1080/17461391.2010.499972.

18. Palucci Vieira LH, Aquino R, Lago-Penas C, Munhoz Martins GH, Puggina EF, Barbieri FA. Running Performance in Brazilian Professional Football Players During a Congested Match Schedule. J Strength Cond Res. 2018; 32(2):313–25. Epub 2018/01/26. https://doi.org/10.1519/JSC.0000000000002342 PMID: 29369952.

19. Clemente FM, Figueiredo AJ, Martins FM, Mendes RS, Wong DP. Physical and technical performances are not associated with tactical prominence in U14 soccer matches. Research in sports medicine (Print). 2018; 24(4):352–62. Epub 2016/10/30. https://doi.org/10.1080/15438627.2016.1222277 PMID: 27533018.

20. Aquino R, Carling C, Palucci Vieira LH, Martins G, Jabor G, Machado J, et al. Influence of Situational Variables, Team Formation, and Playing Position on Match Running Performance and Social Network Analysis in Brazilian Professional Soccer Players. J Strength Cond Res. 2018. Epub 2018/07/10. https://doi.org/10.1519/JSC.0000000000002725 PMID: 29985222.

21. Carling C, Le Gall F, Dupont G. Analysis of repeated high-intensity running performance in professional soccer. J Sports Sci. 2012; 30(4):325–36. Epub 2012/01/18. https://doi.org/10.1080/02640414.2011.652655 PMID: 22248291.
22. Bradley P, Sheldon W, Wooster B, Olsen P, Boanas P, Krustup P. High-intensity running in English FA Premier League soccer matches. J Sports Sci. 2009; 27(2):159–68. Epub 2009/01/21. https://doi.org/10.1080/02640410802512775 PMID: 19153866.

23. Bendiksen M, Pettersen SA, Ingebrigtsen J, Randers MB, Brito J, Mohr M, et al. Application of the Copenhagen Soccer Test in high-level women players—locomotor activities, physiological response and sprint performance. Human movement science. 2013; 32(6):1430–42. Epub 2013/09/11. https://doi.org/10.1016/j.huomov.2013.07.011 PMID: 24016711.

24. Ingebrigtsen J, Dalen T, Hjelde GH, Drust B, Wisloff U. Acceleration and sprint profiles of a professional elite football team in match play. Eur J Sport Sci. 2015; 15(2):101–10. Epub 2014/07/10. https://doi.org/10.1080/17461391.2014.933879 PMID: 25005777.

25. Pettersen SA, Johansen HD, Baptista IAM, Halvorsen P, Johansen D. Quantified Soccer Using Positional Data: A Case Study. Frontiers in Physiology. 2018; 9(866). https://doi.org/10.3389/fphys.2018.00866 PMID: 30034347.

26. Dalen T, Ingebrigtsen J, Ettema G, Hjelde GH, Wisloff U. Player Load, Acceleration, and Deceleration During Forty-Five Competitive Matches of Elite Soccer. J Strength Cond Res. 2016; 30(2):351–9. Epub 2015/06/10. https://doi.org/10.1519/JSC.00000000000001063 PMID: 26057190.

27. Rosnow RL, Rosenthal R, Rubin DB. Contrasts and correlations in effect-size estimation. Psychological science. 2000; 11(6):446–53. Epub 2001/02/24. https://doi.org/10.1111/1467-9280.00287 PMID: 11202488.

28. Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. Medicine and science in sports and exercise. 2009; 41(1):3–13. Epub 2008/12/19. https://doi.org/10.1249/MSS.0b013e3181bcb278 PMID: 19092709.

29. Bangsbo J, Peitersen B. Soccer systems and strategies. Champaign IL: Human Kinetics; 2000.

30. Lago C. The influence of match location, quality of opposition, and match status on possession strategies in professional association football. J Sports Sci. 2009; 27(13):1463–9. Epub 2009/09/17. https://doi.org/10.1080/02640410903131681 PMID: 19757296.

31. Paul DJ, Bradley PS, Nassis GP. Factors affecting match running performance of elite soccer players: shedding some light on the complexity. Int J Sports Physiol Perform. 2015; 10(4):516–9. https://doi.org/10.1123/IJSPP.2015-0029 PMID: 25928752.

32. Castellano J, Blanco-Villasenor A, Alvarez D. Contextual variables and time-motion analysis in soccer. Int J Sports Med. 2011; 32(6):415–21. Epub 2011/05/19. https://doi.org/10.1055/s-0030-1247546 PMID: 21590641.

33. Lago-Penas C, Dellal A. Ball possession strategies in elite soccer according to the evolution of the match-score: the influence of situational variables. J Hum Kinet. 2010; 25:93–100.

34. Redwood-Brown AJ, O’Donoghue PG, Nevill AM, Saward C, Dyer N, Sunderland C. Effects of situational variables on the physical activity profiles of elite soccer players in different score line states. Scand J Med Sci Sports. 2018. Epub 2018/07/29. https://doi.org/10.1111/smss.13271 PMID: 30055045.

35. Gregson W, Drust B, Atkinson G, Salvo VD. Match-to-match variability of high-speed activities in premier league soccer. Int J Sports Med. 2010; 31(4):237–42. Epub 2010/02/17. https://doi.org/10.1055/s-0030-1247546 PMID: 20157871.

36. Krustup P, Bangsbo J. Physiological demands of top-class soccer refereeing in relation to physical capacity: effect of intense intermittent exercise training. J Sports Sci. 2001; 19(11):881–91. Epub 2001/11/07. https://doi.org/10.1080/026404101753113831 PMID: 11695510.

37. Mohr M, Krustup P, Bangsbo J. Match performance of high-standard soccer players with special reference to development of fatigue. J Sports Sci. 2003; 21(7):519–28. Epub 2003/07/10. https://doi.org/10.1080/026404103100071182 PMID: 12848386.

38. Ekblom B. Applied physiology of soccer. Sports medicine (Auckland, NZ). 1986; 3(1):50–60. Epub 1986/01/01. https://doi.org/10.2165/00007256-198603010-00005 PMID: 3633120.

39. Carling C, Bradley P, McCall A, Dupont G. Match-to-match variability in high-speed running activity in a professional soccer team. J Sports Sci. 2016; 34(24):2215–23. Epub 2016/05/05. https://doi.org/10.1080/02640414.2016.1176228 PMID: 27144879.

40. Trewin J, Meylan C, Varley MC, Cronin J. The match-to-match variation of match-running in elite female soccer. J Sci Med Sport. 2018; 21(2):196–201. Epub 2017/06/10. https://doi.org/10.1016/j.jsams.2017.05.009 PMID: 28595867.

41. Lacome M, Simpson BM, Cholley Y, Lambert P, Buchheit M. Small-Sided Games in Elite Soccer: Does One Size Fit All? International journal of sports physiology and performance. 2018; 13(5):568–76. Epub 2017/07/18. https://doi.org/10.1123/ijspp.2017-0214 PMID: 28714774.
42. Silva P, Chung D, Carvalho T, Cardoso T, Davids K, Araujo D, et al. Practice effects on intra-team synergies in football teams. Human movement science. 2016; 46:39–51. Epub 2015/12/29. https://doi.org/10.1016/j.humov.2015.11.017 PMID: 26707679.

43. Di Salvo V, Baron R, Tschan H, Calderon Montero FJ, Bachl N, Pigozzi F. Performance characteristics according to playing position in elite soccer. Int J Sports Med. 2007; 28(3):222–7. Epub 2006/10/07. https://doi.org/10.1055/s-2006-924294 PMID: 17024626.

44. Mohr M, Krstrup P, Andersson H, Kirkendal D, Bangsbo J. Match activities of elite women soccer players at different performance levels. J Strength Cond Res. 2008; 22(2):341–9. Epub 2008/06/14. https://doi.org/10.1519/JSC.0b013e318165fe6 PMID: 18550946.

45. Carling C, Bloomfield J, Nelsen L, Reilly T. The role of motion analysis in elite soccer: contemporary performance measurement techniques and work rate data. Sports medicine (Auckland, NZ). 2008; 38(10):839–62. Epub 2008/09/23. https://doi.org/10.2165/00007256-20083810-00004 PMID: 18803436.