International Journal of EXERCISE SCIENCE

Original Research

External Workloads Vary by Position and Game Result in US-based Professional Soccer Players

GARY M. LONG‡[1], SAM M. JOYCE‡[2,3], ROBERT T. HERRINGTON*[1], KYLE B. FOX†[1], and JACK E. MUMAUGH*[1]

[1]Department of Kinesiology, University of Indianapolis, Indianapolis, IN, USA; [2]Indy Eleven Professional Soccer, Indianapolis, IN, USA; [3]Detroit City FC, Detroit, MI, USA

*Denotes undergraduate student author, †Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 16(6): 688-699, 2023. Professional soccer is a physically demanding sport that requires players to be highly trained. Advances using GPS allow the tracking of external workloads for individual players in practice and competition, however, there is a lack of evidence on how these measures impact match results. Therefore, we analyzed external workloads by player position and determined if they vary depending on the result of competitive matches. External workloads were analyzed in professional soccer players (n = 25) across 28 competitive games. One-way ANOVA determined if workloads varied by position (striker – ST, wide midfielder - WM, central midfielder – CM, wide defender - WD, central defender – CD) or across games won (n = 8), lost (n = 13) or tied (n = 7). Repeated-measures ANOVA assessed differences in workloads specific to each position in each of the result categories. Statistical significance was set at $p < 0.05$. Across all games, more high-speed and very-high speed running was done by ST and WD compared to CD ($p < 0.001$) and CM ($p < 0.001 - 0.02$). Whole-team data showed no differences in any external workload variable with respect to match result ($p > 0.05$), however, in games won ST did more very high-speed running than in losing games ($p = 0.03$) and defending players did more high and very high-speed running in games tied vs. those won or lost ($p < 0.05$). Whole-team external workloads do not vary depending on the match result; however, high speed running may be a differentiating factor at the positional level. Coaches should consider position-specific analysis when examining player workloads.

KEY WORDS: GPS, accelerometry, football

INTRODUCTION

Professional soccer is a physically demanding sport that challenges players to be trained in aerobic endurance, speed, strength, and power (5). Over the past several decades, significant effort has been made to quantify the physiological challenges of gameplay (6, 10, 25, 33), and how to prepare players for those demands (22, 34, 42). Undoubtedly, a central challenge as it relates to this understanding is the highly intermittent nature of the sport. Periods of low and moderate work are interspersed with much higher intensity efforts, providing unique physiological and biomechanical challenges (34, 40). This is further complicated by the differing requirements of player position and the variability of workloads associated with each (1, 8, 10, 11). As a result, greater efforts have been made to develop tools that more accurately quantify, monitor, and manage the "load" placed on soccer players in both practice and competition (2). Classically, loads have been described as either *internal* or *external*, and both are increasingly used as a means of understanding the short and long-term demands of elite-level play (24). Traditionally, internal loads represent the physiological stress on the athlete and are usually measured via heart rate and/or ratings of perceived exertion (RPE), whereas external loads describe movement profiles and include variables such as distance covered, accelerations and decelerations and numbers of high-speed running bouts performed in a specific timeframe (23).

One such method that has gathered a great deal of interest is the use of global positioning systems (GPS) to measure external workloads in various competitive environments. GPS uses time-motion analysis at various sampling frequencies to quantify locomotion, and several studies have demonstrated its validity in field-based team sports, including soccer (14, 30, 39). Subsequently, multiple important lines of enquiry have developed. These include the study of GPS and external workloads as they relate to demands across specific time-frames in the soccer season (e.g. preseason vs. in-season) (29), in small sided vs. traditional 11v11 games (12, 19), in practice vs. games (31) and as means of predicting injury risk in elite players (16). Interestingly, while several investigators have considered external workloads and their potential impact on game *result*, to our knowledge, this has never been studied in elite-level soccer in the United States. In recent work, Nobari, Oliveira, Brito, Perez-Gomez, Clemente and Ardigo (36) determined that several external load measures, including high-speed running and sprint distance vary depending on game result, however, that study was limited by the fact only three losing games were analyzed over the course of the season. This followed a study by Smpokos, Mourikis and Linardakis (43), who demonstrated lower running distances in losing games vs those tied or lost in European competition. This has largely been supported, as two recent studies also showed that professional players in Portugal (8) and Brazil (15) covered greater distances in positive results (wins/ties) vs games lost, however, these analyses were limited by the relatively few games that were included. In contrast, it has been argued that when winning, professional players may in fact *reduce* their workloads, as evidenced by lower levels of high-speed running and distances covered (27). Finally, Andrzejewski, Chmura, Konefał, Kowalczuk and Chmura (3) reported that sprinting actions vary depending on game result in German professional players, but not consistently across playing positions. While these important findings have elucidated the potential significance of analyzing match workloads and their relationship to game outcomes, the relative paucity of evidence and the equivocal nature of their findings calls for further studies in this area. Therefore, our purposes were to (a) determine if a variety of external load measures vary by position and/or game result, and (b) carry out the first of these studies in US-based professional soccer players.

METHODS

Participants

Data were collected from 25 professional soccer players (age 26.3 ± 3.8, weight 169.2 ± 19.9kg), competing in the United Soccer League (USL) across the 2021 regular season. Participants included strikers (ST, *n* = 4), wide midfielders (WM, *n* = 4), central midfielders (CM, *n* = 7), wide defenders (WD, *n* = 3), and central defenders (CD, *n* = 7) as designated by club coaching staff. Analysis was carried out on 28 regular season games, comprising of wins (W, *n* = 8), losses (L, *n* = 13) and ties (T, *n* = 7). Prior to data collection and analysis, all squad members completed a medical history and informed consent that outlined the nature of the study and data collection, management, and analysis. This process was overseen and approved by the University of Indianapolis Human Research Protections Program and Internal Review Board (Study No. 01205), and in adherence with the ethical policies set out by the International Journal of Exercise Science (35). Participants were included if they were officially rostered with the club, had been cleared to play by medical staff, and competed in any of the analyzed matches. Participants were excluded from the analysis if they were unable to play in games due to illness/injury, team selection, or if they chose not to wear the GPS tracking device during competition. Goalkeepers were not included due to their unique movement patterns in practice and gameplay (38).

Protocol

All external load measures were collected across 28 competitive games using the STATSports Apex Athlete GPS monitoring device (STATSports, Newry, Northern Ireland) as described in Table 1. The portable GPS device is placed between the scapulae in a custom-made vest (STATSports, Newry, Northern Ireland) worn under the team jersey, providing positioning data sampled at 10Hz and additional movement data via a tri-axial accelerometer at 100Hz. This device has been demonstrated as valid and reliable (9, 44) and been used extensively in research involving soccer players (18, 21, 37, 41). Each squad member was assigned an individual unit to be worn for all competitive fixtures, with units powered on approximately 30 minutes prior to the start of the game. After matches, GPS units were removed, and data was uploaded to proprietary software (STATSports Apex, STATSports, Newry, Northern Ireland), reviewed, and subsequently exported for statistical analysis. Games took place between May - October 2021 and included both home and away matches.

Table 1. External load variables measured via GPS.

External Load Measure	Description
Total Distance (TD)	Total distance covered at any speed (m)
Total Distance per minute (TDPM)	Total distance covered per minute of game play (m/min)
High-Speed Running Distance (HSRD)	Distance covered at speed 5.5-7m/s, duration >1 s
Number of High-Speed Runs (#HSR)	Number of running bouts as described in HSR
Very High-Speed Running Distance (VHSRD)	Distance covered running at speeds of 7-11m/s
Accelerations (AC)	Accelerations between 3.0-10.0 m/s/s, duration >0.5 s
Decelerations (DC)	Decelerations between 3.0-10.0 m/s/s, duration >0.5 s

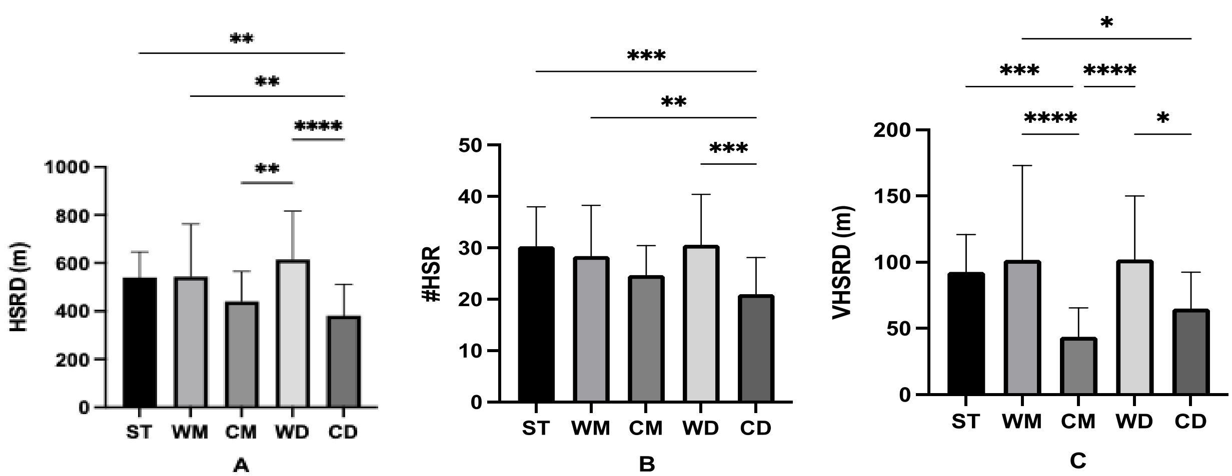
High Metabolic Load Distance (HMLD)	Distance covered performing any activity above 25.5W/kg
Impacts (IM)	Impacts from 9-15G via accelerometry
High Intensity Bursts (HIB)	Three of the following in 20 s timeframe: • Acceleration ≥ 4m/s2 • Deceleration ≥ 4m/s2 • Impact > 11G • High Speed Run

Statistical Analysis

Data was analyzed using GraphPad Prism Version 9 for Mac (GraphPad Software, California, USA) and are presented as mean ± standard deviation. One-way analysis of variance (ANOVA) was used to determine if workloads varied by position (ST, WM, CM, WD, CD) or across games won (W, n = 8), lost (L, n = 13) or tied (T, n = 7). Additionally, repeated-measures ANOVA was used to assess any potential differences in workloads specific to each position in each of the result categories. In each instance, Tukey's multiple comparison post-hoc tests were used to identify individual group differences. Statistical significance was set at $p < 0.05$.

RESULTS

Figure 1 shows external workloads across each position group over the 28 games. Significant differences were identified between position groups in HSRD (A), #HSR (B), VHSRD (C), HIB (D) and IM (E). No significant differences in TD, TDPM, AC, DC and HMLD were reported between position groups.



When analyzed at the whole-team level, external workloads did not vary significantly depending on game result (Table 2), however, VHSRD tended to differ across outcomes (p = 0.06), with players running lower distances in games lost vs. those won or tied. However, in position-specific analyses (Figure 2), it was shown that when games were tied, WD covered significantly greater HSRD than in those won or lost (A). Similarly, CD covered more HSRD in tied vs. winning games (B). ST performed greater amounts of VHSRD in wins vs. losses (C) and WD demonstrated more VHSRD running in games tied than those lost (D). No other differences were seen between position groups across each game outcome.

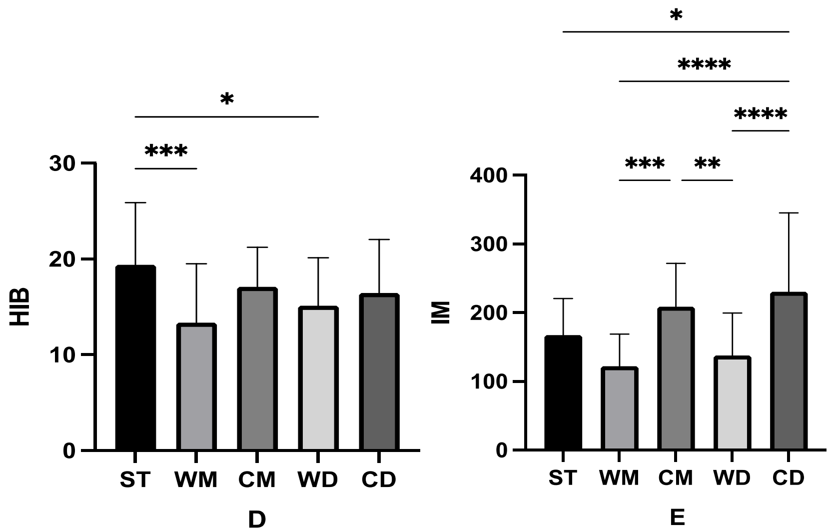


Figure 1 (A-E). Mean external workloads by position. *$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$

Table 2. Whole-team external load measures by game results

	Win (*n* = 8)	Loss (*n* = 13)	Tie (*n* = 7)	*p*-value
TD	8320 ± 719	8324 ± 555	8416 ± 771	0.88
TDPM	82.1 ± 17.2	76.5 ± 14.8	84.1 ± 19.2	0.80
HSRD	472.6 ± 55.1	457.7 ± 68.4	509 ± 84.6	0.26
#HSR	25.1 ± 2.2	25.7 ± 3.5	26.3 ± 3.5	0.69
VHSRD	78.9 ± 19.6	65.1 ± 13.9	82.7 ± 19.4	0.06
AC	41 ± 3.7	42.7 ± 6.7	37.7 ± 11.2	0.36
DC	50.3 ± 6.9	50.1 ± 7.7	47.5 ± 11.2	0.62
HMLD	1218 ± 171	1229 ± 162	1262 ± 223	0.86
IM	159.5 ± 14.4	173.8 ± 19	192.7 ± 75.8	0.28
HIB	15.2 ± 1.7	16 ± 1.9	17.1 ± 3.9	0.25

DISCUSSION

The aim of this study was to analyze GPS-derived external workloads across position and game result in US-based professional soccer players. We report significant differences in several workload measures across position groups over an entire season. Additionally, our data indicates that high/very high-speed running varies by position depending on match outcome, despite no differences at the "whole-team" level. These findings add to a growing understanding that the analysis of external workloads may be used as an important adjuvant tool in monitoring player performance and ultimately, increasing game success.

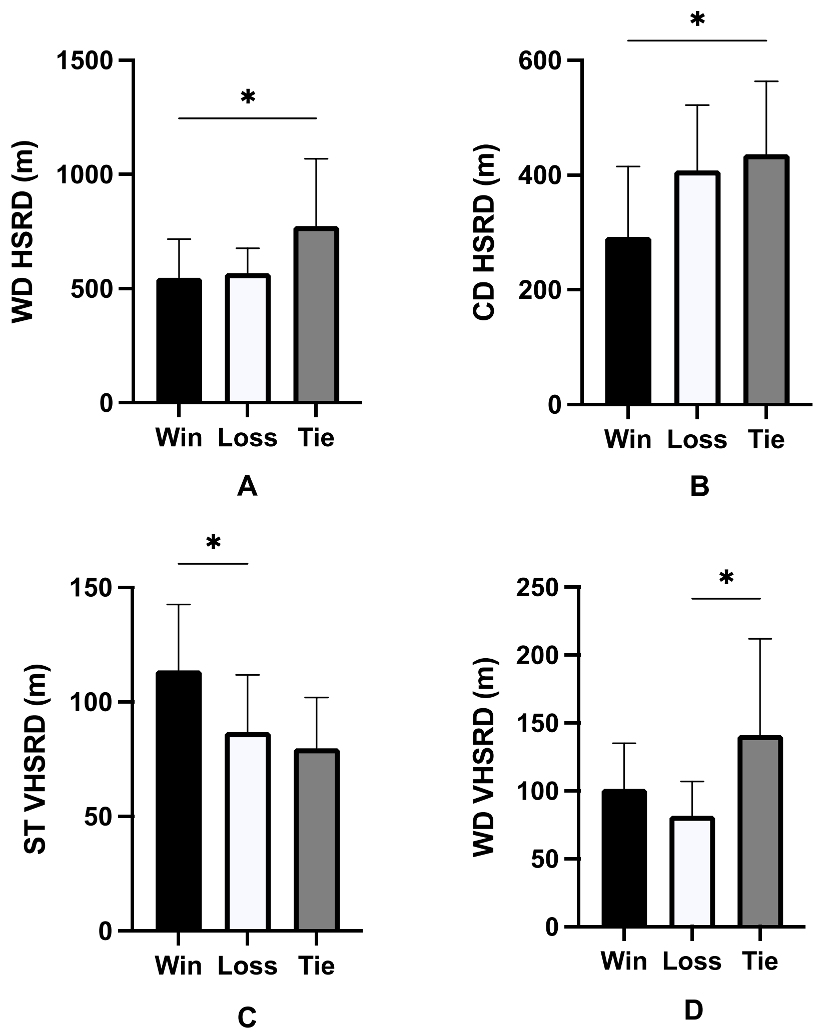


Figure 2 (A-D). Workloads by position across each game result. *$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; **** $p < 0.0001$

When analyzed over a 28-game season, our data demonstrates remarkably similar total mean distances covered by the various position groups (min - ST: 8494 ± 1863 to max - WD: 8886 ± 2427 m), and interestingly, lower overall output than described previously for professional players. Earlier studies by Bangsbo (4) and Mohr, Krustrup and Bangsbo (32) reported that elite players cover distances of > 10,000 m during match play, and these numbers have been similarly reported in recent studies using GPS analysis in "first team" (28, 45) and "developmental" (U18-U23) players (1, 41). Our data would seem to more closely match that of Nobari, Oliveira, Brito, Perez-Gomez, Clemente and Ardigo (36), who presented distances of < 10,000 m covered in the Iranian Premier League. While it could be suggested the distances reported in this study are reflective of a lower standard of play, there is compelling evidence that contextual factors such as team formation, location (home or away), and tactical preferences of coaching staff may all play a role in player activity profiles, including running distance (7, 8, 17, 26). Indeed, raw data (not presented here) demonstrate covered distances ranging from 5667 to 12,680 m in our participants over the course of the season, indicating significant variability across individual players.

As noted, we did not see a specific position group cover greater total distances during match play. This was unexpected, as several investigators have shown that central midfield players tend to outperform other positions in this category (8, 28, 43, 45). This is often explained by the fact that they have both offensive and defensive responsibilities, and as such, are required to cover more ground over the course of a game. This contrasts with other positions (most notably central defenders and strikers) who can be more limited in their responsibilities and as such, may not have the same overall distance demands. In contrast, we report that higher intensity efforts did differ by position. This is significant, as it has been previously postulated that high-speed running efforts are closely linked to performance (5) and can be a differentiating factor between standards of play (32). In HSRD, #HSR and VHSR, strikers and wide players (WD and WM) outperformed those in central positions (CD and CM). Interestingly, the most profound differences were between WD and CD in HSR, with the former group covering approximately 230 m more HSR in competition. Similarly, WD covered an average of 37 m and 58 m more VHSR than CD and CM, respectively. Additionally, ST performed approximately 158 m more HSR than CD, and 49 m more VHSR than CM. These discrepancies would seem to support previous findings in this area. Mallo, Mena, Nevado and Paredes (28) reported similar patterns of high and very high-speed running across position groups in elite-level Spanish players, with comparable findings demonstrated in the English Premier League (10), Premier League developmental players (1), and in the Portuguese second division (8). While variations in measurement and running speed thresholds makes absolute comparisons between studies a challenge, the overall consistency of these findings across competitive levels and geographical location would suggest these demands should be an important consideration in player preparation. Wide midfielders and strikers are often tasked with dynamic movements to break down the opposing defense, with wide defenders increasingly being asked to support attacking play in a similar way. As such, coaches should design training plans that develop repeat-sprint ability and high intensity running capacity in these position groups.

We show that despite lower high-speed running demands, central players (CB and CM) performed the greatest number of impacts in competition. Measured via accelerometry, impacts are acute forces of > 9G acting on players, and involve actions such as jumping, stepping, collisions and "cutting" motions (20). It stands to reason that these actions may be more prominent in these positions. Bloomfield, Polman and O'Donoghue (10) reported that Premier League defenders performed more shuffling, skipping and lateral movements despite lower running distances, with midfielders engaged in more jumping, sliding and diving. This may well be reflected in the impact data we report herein. Moreover, central areas of the field are often the most congested, hence these shorter, impactful movements to either evade or challenge opponents may be more frequent. This is an important and unique finding, as this variable is often ignored in external load analyses. We are aware of no other work that has compared impacts across position in soccer, and this finding may indicate a need for more specialized training for CD and CM players in the professional game.

Our data indicate that when analyzed at the whole-team level, no significant differences in external workloads are seen between won, lost, and tied games. This contradicts the findings of several investigators who note discrepancies in whole-team performance measures across match outcomes. In elite-level European games, Smpokos, Mourikis and Linardakis (43) and Barrera, Sarmento, Clemente, Field and Figueiredo (8) found that total distances covered were higher in wins and ties vs. losses, however, no differences were seen in high-intensity actions. Conversely, it was recently shown that average speed was higher in *losing* games when measured in Iranian players, with no differences reported in total distance, sprints and high-speed running (36). In each case, tactical variations and/or purposeful regulation of effort are proposed as explanations for differences identified. For example, it may be that teams in winning positions tend to "manage" the game via possession and an overall slower style of play. On the other hand, coaches may emphasize a counterattacking system that requires intermittent bouts of long distance running, or teams in losing positions may be encouraged to work harder and pressure opponents to force a positive result. While we do not dispute such factors are important, we suggest that a somewhat "superficial" whole-team analysis may miss important positional differences across results, particularly in higher-speed running. Indeed, the different positional demands previously described would suggest including this as *necessary* factor when monitoring external loads and associated results. To this end, while we report no differences at the whole-team level in any external load measure, significant differences in high and very-high speed running were seen in WD, ST and CD across wins, losses and ties. Specifically, our data indicates that ST did more VHSR in games won vs. those lost. This would support the work of Andrzejewski, Chmura, Konefał, Kowalczuk and Chmura (3) and Chmura, Konefał, Chmura, Kowalczuk, Zając, Rokita and Andrzejewski (13) who found that in winning games, strikers covered a greater amount of higher-speed running than those lost. This may be because forward players are traditionally required to make unpredictable, very high-speed runs to beat defenders, attack crossed balls and dribble at speed in offensive areas of the field. Indeed, the evidence would suggest the ability of forwards to carry out these actions may be integral to positive match outcomes. As such, coaches may want to consider spending more time on near-maximal/maximal running performance with their attacking players.

We also show that WD did significantly more HSR and VHSR in games tied compared to those won and lost, and CD performed more HSR in tied games vs. those won. The fact that defensive players (both wide and central) performed more higher-speed work in tied games is an intriguing finding. It could be argued that in winning positions, lower levels of HSR for defenders may simply reflect an attacking dominance that requires less effort from those positions. Indeed, it has previously been shown that central and wide defenders sprinted less in games won than those lost (3, 13), however, our findings of greater work in tied games seems to be unique in the literature. It may be that the lower HSR and VHSR from WD in losing games reflects opposition dominance and the need for those players to concede possession or "sit in and defend", whereas in games tied the focus may shift to greater higher speed work to force a winning result. Undoubtedly, future work should continue to interrogate the actions of defensive players as it relates to games success.

We believe this is the first study to analyze external workloads and their potential impact on game results in US-based professional soccer players. However, several limitations should be considered when interpreting our findings. First, we present data on only one team across one competitive season. As such, inherent characteristics of individual players and coaching preferences may challenge the generalizability of our findings. Additionally, as there is compelling evidence that tactical variations (8), travel (17) and opposition quality (26) impact player performance, including more teams in future analyses might shed light on the significance of these confounding variables. Finally, while players were designated specific position groups by coaching staff, it is conceivable that these may have been altered either between or within games due to injury or a change in tactical approach.

In conclusion, we have shown that US-based professional soccer players exhibit varying external loads depending on playing position, supporting previous work in this area. ST, WD and WM carry out more HSR and VHSR running than those in central positions, despite the latter experiencing more impacts during gameplay. Importantly, we have shown that a "whole-team" external load analysis may not be sensitive enough to determine the impact of these measures on game result. However, at the positional level, we note that ST, WD and CD perform different levels of higher-speed efforts depending on game outcome. Coaches can use this information to more intentionally prepare players for the demands of their position, and should consider including playing position as an important criterion when analyzing workloads and any relationship to game success.

ACKNOWLEDGEMENTS

The authors sincerely thank the players and coaching staff for their cooperation in this research project.

REFERENCES

1. Abbott W, Brickley G, Smeeton NJ. Physical demands of playing position within English premier league academy soccer. J Hum Sport Exerc 13(2): 1-11, 2018.

2. Akenhead R, Nassis GP. Training load and player monitoring in high-level football: Current practice and perceptions. Int J Sports Physiol Perform 11(5): 587-593, 2016.

3. Andrzejewski M, Chmura P, Konefał M, Kowalczuk E, Chmura J. Match outcome and sprinting activities in match play by elite German soccer players. J Sports Med Phys Fitness 58: 785-792, 2018.

4. Bangsbo J. The physiology of soccer--with special reference to intense intermittent exercise. Acta Physiol Scand Suppl 619: 1-155, 1994.

5. Bangsbo J, Mohr M, Krustrup P. Physical and metabolic demands of training and match-play in the elite football player. J Sports Sci 24(7): 665-674, 2006.

6. Bangsbo J, Norregaard L, Thorso F. Activity profile of competition soccer. Can J Sport Sci 16(2): 110-116, 1991.

7. Baptista J, Travassos B, Gonçalves B, Mourão P, Viana JL, Sampaio J. Exploring the effects of playing formations on tactical behavior and external workload during football small-sided games. J Strength Cond Res 34(7): 2024-2030, 2020.

8. Barrera J, Sarmento H, Clemente FM, Field A, Figueiredo AJ. The effect of contextual variables on match performance across different playing positions in professional portuguese soccer players. Int J Environ Res Public Health 18(10): 5175, 2021.

9. Beato M, Bartolini D, Ghia G, Zamparo P. Accuracy of a 10 hz gps unit in measuring shuttle velocity performed at different speeds and distances (5 - 20 m). J Hum Kinet 54: 15-22, 2016.

10. Bloomfield J, Polman R, O'Donoghue P. Physical demands of different positions in FA premier league soccer. J Sports Sci Med 6(1): 63-70, 2007.

11. Borghi S, Colombo D, La Torre A, Banfi G, Bonato M, Vitale JA. Differences in gps variables according to playing formations and playing positions in u19 male soccer players. Res Sports Med 29(3): 225-239, 2021.

12. Castellano J, Casamichana D. Differences in the number of accelerations between small-sided games and friendly matches in soccer. J Sports Sci Med 12(1): 209-210, 2013.

13. Chmura P, Konefał M, Chmura J, Kowalczuk E, Zając T, Rokita A, Andrzejewski M. Match outcome and running performance in different intensity ranges among elite soccer players. Biol Sport 35(2): 197-203, 2018.

14. Coutts AJ, Duffield R. Validity and reliability of gps devices for measuring movement demands of team sports. J Sci Med Sport 13(1): 133-135, 2010.

15. Cruz Gonçalves LG, Manuel Lemente F, Palucci Vieira LH, Bedo B, Fuini Puggina E, Moura E, Mesquita F, Pereira Santiago PR, Almeida R, Aquino R. Effects of match location, quality of opposition, match outcome, and playing position on load parameters and players' prominence during official matches in professional soccer players. Hum Mov 22(3): 35-44, 2021.

16. Ehrmann FE, Duncan CS, Sindhusake D, Franzsen WN, Greene DA. Gps and injury prevention in professional soccer. J Strength Cond Res 30(2): 360-367, 2016.

17. Fowler P, Duffield R, Vaile J. Effects of domestic air travel on technical and tactical performance and recovery in soccer. Int J Sports Physiol Perform 9(3): 378-386, 2014.

18. García A, Castellano J, Gómez-Díaz A, Cos F, Casamichana D. Positional demands for various-sided games with goalkeepers according to the most demanding passages of match play in football. Biol Sport 36: 171-180, 2019.

19. Gaudino P, Alberti G, Iaia FM. Estimated metabolic and mechanical demands during different small-sided games in elite soccer players. Hum Mov Sci 36: 123-133, 2014.

20. Grainger A, McMahon J, Comfort P. Quantification of inertial sensor impacts using video analysis in elite level rugby union. Sport Perform Sci Rep 1: 90, 2020.

21. Hannon MP, Coleman NM, Parker LJF, McKeown J, Unnithan VB, Close GL, Drust B, Morton JP. Seasonal training and match load and micro-cycle periodization in male premier league academy soccer players. J Sports Sci 39(16): 1838-1849, 2021.

22. Hoff J, Helgerud J. Endurance and strength training for soccer players. Sports Med 34(3): 165-180, 2004.

23. Impellizzeri FM, Marcora SM, Coutts AJ. Internal and external training load: 15 years on. Int J Sports Physiol Perform 14(2): 270-273, 2019.

24. Jaspers A, Brink MS, Probst SGM, Frencken WGP, Helsen WF. Relationships between training load indicators and training outcomes in professional soccer. Sports Med 47(3): 533-544, 2017.

25. Krustrup P, Mohr M, Ellingsgaard H, Bangsbo J. Physical demands during an elite female soccer game: Importance of training status. Med Sci Sports Exerc 37(7): 1242-1248, 2005.

26. Lago C. The influence of match location, quality of opposition, and match status on possession strategies in professional association football. J Sports Sci 27(13): 1463-1469, 2009.

27. Lago C, Casais L, Dominguez E, Sampaio J. The effects of situational variables on distance covered at various speeds in elite soccer. Eur J Sport Sci 10(2): 103-109, 2010.

28. Mallo J, Mena E, Nevado F, Paredes V. Physical demands of top-class soccer friendly matches in relation to a playing position using global positioning system technology. J Hum Kinet 47(1): 179-188, 2015.

29. Malone JJ, Di Michele R, Morgans R, Burgess D, Morton JP, Drust B. Seasonal training-load quantification in elite english premier league soccer players. Int J Sports Physiol Perform 10(4): 489-497, 2015.

30. Malone JJ, Lovell R, Varley MC, Coutts AJ. Unpacking the black box: Applications and considerations for using gps devices in sport. Int J Sports Physiol Perform 12(Suppl 2): S218-S1226, 2017.

31. McFadden BA, Walker AJ, Bozzini BN, Sanders DJ, Arent SM. Comparison of internal and external training loads in male and female collegiate soccer players during practices vs. games. J Strength Cond Res 34(4): 969-974, 2020.

32. Mohr M, Krustrup P, Bangsbo J. Match performance of high-standard soccer players with special reference to development of fatigue. J Sports Sci 21(7): 519-528, 2003.

33. Mohr M, Krustrup P, Bangsbo J. Fatigue in soccer: A brief review. J Sports Sci 23(6): 593-599, 2005.

34. Morgans R, Orme P, Anderson L, Drust B. Principles and practices of training for soccer. J Sport Health Sci 3(4): 251-257, 2014.

35. Navalta JW, Stone WJ, Lyons TS. Ethical issues relating to scientific discovery in exercise science. Int J Exerc Sci 12(1): 1-8, 2019.

36. Nobari H, Oliveira R, Brito JP, Perez-Gomez J, Clemente FM, Ardigo LP. Comparison of running distance variables and body load in competitions based on their results: A full-season study of professional soccer players. Int J Environ Res Public Health 18(4): 2077, 2021.

37. Owen AL, Newton M, Shovlin A, Malone S. The use of small-sided games as an aerobic fitness assessment supplement within elite level professional soccer. J Hum Kinet 71(1): 243-253, 2020.

38. Perez V, Malone S, Sala-Perez L, Lapuente-Sagarra M, Vázquez M, Del Coso J. Activity monitoring in professional soccer goalkeepers during training and match play. Int J Perform Anal Sport 20(1): 19-30, 2020.

39. Rampinini E, Alberti G, Fiorenza M, Riggio M, Sassi R, Borges T, Coutts A. Accuracy of gps devices for measuring high-intensity running in field-based team sports. Int J Sports Med 36(1): 49-53, 2014.

40. Reche-Soto P, Cardona-Nieto D, Diaz-Suarez A, Bastida-Castillo A, Gomez-Carmona C, Garcia-Rubio J, Pino-Ortega J. Player load and metabolic power dynamics as load quantifiers in soccer. J Hum Kinet 69(1): 259-269, 2019.

41. Reynolds J, Connor M, Jamil M, Beato M. Quantifying and comparing the match demands of u18, u23, and 1st team English professional soccer players. Front Physiol 12: 706451, 2021.

42. Silva JR, Nassis GP, Rebelo A. Strength training in soccer with a specific focus on highly trained players. Sports Med Open 1(1): 17, 2015.

43. Smpokos E, Mourikis C, Linardakis M. Seasonal physical performance of a professional team's football players in a national league and European matches. J Hum Sport Exerc 13(4): 720-730, 2018.

44. Thornton HR, Nelson AR, Delaney JA, Serpiello FR, Duthie GM. Interunit reliability and effect of data-processing methods of global positioning systems. Int J Sports Physiol Perform 14(4): 432-438, 2019.

45. Torreño N, Munguia-Izquierdo D, Coutts A, Sáez de Villarreal E, Asian-Clemente J, Suarez-Arrones L. Relationship between external and internal loads of professional soccer players during full matches in official games using global positioning systems and heart-rate technology. Int J Sports Physiol Perform 11(7): 940-946, 2016.