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Title	'Bridging the gap': Differences in training and match physical load in 1st team and U23 players from the English Premier League
Type	Article
URL	https://clok.uclan.ac.uk/48165/
DOI	https://doi.org/10.1177/17479541231186227
Date	2023
Citation	Kavanagh, Ronan, Carling, Christoper, Malone, Shane, Di Michele, Rocco, Morgans, Ryland and Rhodes, David (2023) 'Bridging the gap': Differences in training and match physical load in 1st team and U23 players from the English Premier League. International Journal of Sports Science & Coaching. ISSN 1747-9541
Creators	Kavanagh, Ronan, Carling, Christoper, Malone, Shane, Di Michele, Rocco, Morgans, Ryland and Rhodes, David

It is advisable to refer to the publisher's version if you intend to cite from the work. https://doi.org/10.1177/17479541231186227

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'Bridging the Gap': Differences in training and match physical load in 1st team and U23 players from the English Premier League

Word Count:

3780

Disclosure of interest:

The authors report no conflict of interest.

ABSTRACT

Objectives: To explore the differences in training and match load in English Premier League (EPL) 1st team and U23 players. Identifying differences in relative and absolute physical outputs in relation to Maximal Aerobic Speed (MAS) and Maximal Sprint Speed (MSS) and how this informs monitoring and training prescription. **Methods:** Two groups of full-time professional football players (1st team, n = 24 and U23 squad, n = 27) participated in this study. Training and match data were categorised into weekly blocks from Monday to Sunday. Each player's weekly total was then averaged to provide a squad average for each metric examined. **Results:** Match analysis identified significantly higher distance covered above 120% MAS and distance between 120% MAS and 85% MSS ($p=0.04$, ES=0.64; $p<0.01$, ES=1.13) for the 1st team. Distance above 85% MSS was significantly higher for the U23's ($p<0.01$, ES=2.92). Training and match data during one-match weeks displayed significantly higher differences in all high speed variables for 1st team players compared to U23 players ($p \leq 0.05$, ES=0.82-1.78). Analysis of training and match data during a two -match week displayed no significant differences for all physical variables ($p>0.05$). **Conclusions:** Practitioners should consider the utilisation of individual relative thresholds to identify differences between physical performance variables during training and matches for 1st team and U23 players. Utilising these comparisons to inform training design, could maximise players physical development and potential for successful transition. Importantly, these findings relate to only one EPL club and ideally practitioners should assess their own players relative training and game outputs.

Keywords: football, MAS, speed thresholds, player development

Introduction

Physical performance in football is characterised by its intermittent multi-directional nature, that requires well-developed aerobic and anaerobic fitness (1, 2). In professional football the management of high-speed running (HSR) is of huge importance from a performance and injury prevention perspective (3). Historically, absolute HSR and sprint distance (SD) have been represented by generic speed thresholds (or zones) of 5.5 $m \cdot s^{-1}$ and 7 $m \cdot s^{-1}$, respectively (4). The quantification of high velocity metrics has been debated in the historical evidence base since its inception, with a recent shift from absolute to relative thresholds (5, 6) to better align the individualised nature of the exercise continuum (7). This focus provides a more accurate representation of the actual individual player output, that are potentially underestimating when absolute thresholds are applied (5). Current literature has paid particular attention to these high velocity physical metrics to guide training approaches to optimise performance and reduce injury risk (8, 9). That said, research surrounding 'bridging the gap' for these metrics between U23 and 1st team players is still lacking. Transitional research for academy players into full-time training has been completed, noting significant increases in training load, with no differences noted between U18 and U23 teams (10). This body of work failed to consider the transition from the U23 squad to the 1st team. Understanding these transitional differences and subsequent physical demands is essential for player development (11).

Traditionally, high velocity thresholds and subsequent training zones have been determined by training at a specific percentage of the athlete's maximum speed (4) and thus represents a relative approach to defining thresholds. Understanding the intensity of maximal speed efforts across different age groups may support practitioners to optimise the long-term player development process (12). However, the utilisation of this single method to determine a player's training prescription is limited, as no consideration has been made regarding the players aerobic capacity (13, 14). The existing literature states that total distance (TD) correlates with high levels of aerobic fitness (1, 15, 16) and differentiates between the level of player (17). However, caution must be considered as TD alone does not account for the intensity at which the player has worked. Essentially for a player to meet the demands of the modern game, individualised aerobic and anaerobic capacities must be identified to accurately prescribe training for each player (18).

The addition of Maximal Aerobic Speed (MAS) and Maximal Sprint Speed (MSS) has been identified as an accurate method to provide greater context to training prescription, as it allows the identification of each players aerobic and anaerobic capacity (19). Calculation of MAS allows practitioners to identify the athletes anaerobic speed reserve (ASR) and optimise specific match conditioning prescription (18). Maximal Aerobic Speed has been defined as a practical and time efficient method to assess the aerobic energy system in team sport athletes (20). One of the major benefits of MAS as a measure of aerobic fitness is the ease at which practitioners can assess large groups of athletes without any expensive equipment required. Recent evidence has identified a very large linear relationship between time above MAS (Time >MAS) and changes in MAS ($r = 0.77$) (18). However, generic thresholds showed an unclear correlation with changes in aerobic fitness (18). Therefore, the assessment of MAS as a performance indicator is warranted within elite football. Maximal Aerobic Speed has previously been used to identify changes in physical fitness in elite youth football players (18) and its usefulness in an applied setting to prescribe training loads has been previously validated (20). Individualising speed thresholds also provides a more 'player-centred' approach to external workload which may support practitioners better understand the differences between 1st team and U23 players.

Currently there is scant literature examining 1st team and U23 physical outputs in professional football. Employing individualised thresholds will provide more precise workload information relative to the individual player's physical characteristics regardless of maturation status. Physical outputs are monitored daily to ensure players are physically prepared for the demands of match-play. The potential benefits of highly developed physical characteristics are important to ensure U23 players are appropriately prepared for the potential demands of 1st team training and match-play. Therefore, the aims of the present study were to analyse the physical performance metrics within an elite English Premier League (EPL) football club, specifically; 1) to identify differences between 1st team and U23 players in relative physical outputs in relation to MAS and MSS; 2) to identify the differences between 1st team and U23 players in absolute physical outputs; and 3) to compare the differences between relative outputs (utilising MAS and MSS) and absolute values and how this informs monitoring and training prescription.

Methods

The present study was designed to evaluate the differences in weekly training and match demands between 1st team and U23 professional football players from an EPL Club using absolute and relative speed thresholds. Training and match data was collected over a 7-month period during the 2019-20 season. A full season of data was not obtained due to the COVID-19 interruption. All players trained on a full-time basis and only completed Premier League, Professional Development League and cup competitions, namely FA Cup, League Cup and U23 Premier League Cup.

Participants

Two groups of full-time professional football players were recruited to participate in this study. Players were recruited from the 1st team (n = 24), age 29.8 ± 3.4 yrs; height 183.7 ± 5.2 cm; weight 83.7 ± 6.9 kg and U23 team (n = 27), age 19.9 ± 1.5 yrs; height 184.9 ± 6.5cm; weight 81.9 ± 8.2 kg. Although, all data was gathered as a condition of employment in which players are routinely monitored over the course of the competitive season, approval for the study from the club was obtained (21). Formal ethics was approved by the University of Central Lancashire (BAHSS 646 dated 17/04/2019) and the study was conducted in accordance with the Helsinki Declaration. To ensure confidentiality, all data were anonymised prior to analysis. To be included in the weekly analysis players were required to complete all training sessions during the study period and be included in the match-day squad. Players who did not complete all sessions were removed from the analysis for each week. Relevant risk assessments and safety protocols were completed and adhered to in accordance with the football governing body, The Premier League and the academic institution.

Experimental Design

A global positioning system (GPS) (Apex, STATSports, Ireland) was used to quantify work-load data collected from all pitch training sessions (1st team n = 139; U23 n = 132) and U23 competitive matches (n = 18). The GPS units were placed between the scapulae of the players in bespoke vests. The GPS component sample rate was 10hz while the accelerometer within the unit samples at 100hz. Such GPS devices have an acceptable level of accuracy and reliability when measuring the speed of movement within intermittent exercise (22, 23). Specifically, the Apex units have shown good levels of accuracy in sport specific metrics in addition to non-significant and trivial differences when measuring peak velocity against the gold standard measure (Stalker ATS 2,34.7 GHz, United States) (24). Competitive 1st team match data (n = 24) was recorded using a semi-automated camera tracking system (Second Spectrum, California, USA), which has previously been installed to standardise match data collection in the EPL. The camera system is utilised due to the technological limitations of GPS devices whereby satellite signal can be affected by stadiums and surrounding buildings, which can lead to measurement error (25). Following each training session and match, data was downloaded into STATSports (APEX 1.7) analysis software. Processing Second Spectrum in this way allows for the raw optical tracking data to be subjected to the same smoothing process that is employed by STATSports. Second Spectrum has previously met industry standards as reported by the FIFA program (26). Training and match data were categorised into weekly blocks from Monday to Sunday. Squad average was calculated and examined for each metric.

Data collected for analysis from the GPS included: total distance (TD) covered, measured in metres; explosive distance (ED), distance covered accelerating and decelerating greater than 2 $m \cdot s^{-2}$ measured in metres; HSR distance, distance covered above 5.5 $m \cdot s^{-1}$ measured in metres; sprint distance (SD), distance covered above 7 $m \cdot s^{-1}$ measured in metres; distance covered at speed above each player's MAS measured in metres; time spent at speed above each player's MAS measured in minutes; distance above 120% MAS (relative high-speed running distance) measured in metres, distance covered at speed above 120% of each players' individual MAS measured in metres; distance above 85% MSS (relative sprint distance) measured in metres, distance covered at speeds above 85% of each player's individual MSS (9) measured in metres; Zone 5 speed, distance covered at speeds between 5.5 $m \cdot s^{-1}$ and 7 $m \cdot s^{-1}$ measured in metres; distance between 120% MAS and 85% MSS (relative distance Zone 5) measured in metres, distance covered at speeds between 120% of MAS and 85% MSS measured in metres.

Maximal Aerobic Speed test

During the pre-season period both the 1st and U23 players completed a MAS test to estimate velocity at VO^2max. All players performed the MAS test during the first week of pre-season and this was repeated during the third week of pre-season following three days of recovery from the previous match. The previously validated MAS protocol was a 5-minute maximum effort time trial (20). This 5-minute time trial has previously proven to correlate with MAS assessed via laboratory gas analysis (20). A 500 m circular route was established prior to the test (see Figure 1). Players were informed how much time was remaining at one-minute intervals until test completion to ensure players were performing maximally (27). This verbal encouragement has been shown to be a motivational requirement for laboratory assessments of time to exhaustion and central fatigue (28).

****Insert Figure 1****

Prior to the test protocol an extensive 15-minute dynamic warm up, including light jogging, dynamic stretching and then intense, football specific movements were conducted. To standardise the environment, testing was performed on an outdoor grass surface with players wearing the same football boots throughout the investigation. The 5-minute test data was examined using the STATSports (APEX, 1.7) software. Maximal Aerobic Speed ($m \cdot s^{-1}$) was determined by dividing TD covered by the test duration (300s) (20).

Maximum Sprint Speed

During the pre-season period a linear speed phase consisting of twice weekly peak speed exposures was conducted. Following this, each player's maximum speed reached during this period was established using GPS (Apex, STATSports, Ireland). The researchers decided to take the maximum speed from this period as an average peak speed per session may be influenced by session content and positional demands and therefore would not be a true reflection of the players peak speed capacity. If a player produced a new MSS during the season this was adjusted within the software. New speed bands were customised in the STATSports (APEX, 1.7) software using each individuals MAS and 120% MAS to allow for analysis of individualised running demands (18). Sprint entry speed was set at 85% of each player's MSS using STATSports (APEX, 1.7) software. All peak speeds were validated visually by the researchers using STATSports (APEX, 1.7) software to ensure no anomalies were included in the analysis. Players that did not participate in full team training each week were removed from analysis.

Statistical Analysis

Prior to analysis, the data were checked for normality using a Shapiro-Wilk test. Data was presented as mean ± standard deviation, and 95% confidence intervals (CI). Data was analysed using SPSS 26.0 (SPSS Inc., Chicago, IL, USA). All examined GPS metrics were compared using independent-sample t-tests to determine if any significant differences between team total match outputs, and between players weekly outputs, across all physical performance metrics were observed. For weekly outputs, separate comparisons were made, respectively, for one-match and two-match weeks. For each player, average weekly outputs were calculated related to one-match or two-match weeks, and subsequently used for comparisons between 1st team and U23 players. Statistical significance was set at $p<0.05$. The absolute standardised mean difference (Cohen's d) between 1st team and U23 players was taken as the effect size (ES). The ES magnitude was interpreted according to the following criteria: <0.2, trivial; 0.2 to 0.5, small; 0.5 to 0.8, moderate; >0.8, large (18).

Results

For the 1st team players, the mean ± standard deviation MAS and MSS were, 4.63 ± 0.21 $m{\cdot}s^{-1}$ and 9.53 $m{\cdot}s^{-1}$ ± 0.48 $m{\cdot}s^{-1}$ respectively, while the U23 players were 4.74 ± 0.14 $m{\cdot}s^{-1}$ and 9.34 $m{\cdot}s^{-1}$ ± 0.44 $m{\cdot}s^{-1}$ respectively. The difference between 1st team and U23 players was not statistically significant for both MAS (p=0.17) and MSS (p=0.36). Table 1 summarises the differences between team total match outputs for 1st team and U23 players.

****Insert Table 1****

Analysis of match outputs identified significantly higher distance at speed >120% MAS (p=0.04, ES = 0.62, moderate) and distance between 120% MAS and 85% MSS (p<0.01, ES = 1.13, large), and significantly lower (p<0.01) (ES = 2.92, large) distance at speed >85% maximum speed, in 1st team vs. U23 players. No significant differences were observed for TD (p=0.06), HSR (p=0.15), SD (p=0.76), time at speed > MAS (p=0.95), distance at speed > MAS (p=0.81), Zone-5 distance (p=0.09), and ED (p=0.08) (Table 1).

Table 2 summarises the differences in average training and match output between 1st team and U23 players in one-match weeks.

****Insert Table 2****

Analysis of average weekly outputs for one-match weeks identified significantly greater values for 1st team vs. U23 players in distance at speed >120% MAS (p<0.01, ES = 1.54, large), HSR (p<0.01, ES = 1.78, large), SD (p=0.01, ES = 1.08, large), time at speed >MAS (p=0.04, ES = 0.82, large), distance at speed >MAS (p<0.02, ES = 1.10, large), Zone-5 distance (p<0.01, ES = 1.48, large) and distance between 120% MAS and 85% MSS (p<0.01, ES = 1.63, large). No significant differences were found for TD (p=0.59), distance at speed >85% MSS (p=0.10), and ED (p=0.81).

Table 3 summarises the differences in average training and match output between 1st team and U23 players in two-match weeks.

****Insert Table 3****

No significant differences were found for TD (p=0.38), distance at speed >120% MAS (p=0.24), HSR (p=0.15), SD (p=0.25), distance at speed >85% MSS (p=0.17), time at speed >MAS (p=0.48), distance at speed >MAS (p=0.40), Zone-5 distance (p=0.40), distance between 120% MAS and 85% MSS (p=0.06), and ED (p=0.52).

Discussion

The aim of the present study was to explore the differences in weekly training and match load in EPL 1st team and U23 players. Identifying differences in relative and absolute physical outputs in relation to MAS and MSS and how this informs monitoring and training prescription is practically important. Previously, significant increases in all physical metrics for players transitioning to full-time football have been noted, although no differences between U18 and U23 teams were reported (10). In the present study match-play metrics displayed significantly higher outputs for 1st team players in relative HSR and relative Zone-5 distance when utilising MAS and MSS to calculate. The U23 players did display significantly greater distance >85% MSS than the 1st team during match-play. Al Hadadd et al. (12) suggested sprinting speed is age dependent in young football players and likely to discriminate between competitive standards, although this study only explored U13–U18 players. No significant differences were observed for any of the absolute HSR variables, highlighting the need for aerobic and anaerobic relative thresholds to be set in addition to absolute thresholds (19, 29) to optimise match-specific conditioning (18). The present study highlights that the 1st team players examined cover significantly more distance >120% MAS than the U23 players during matches, emphasising the physical gap between 1st team and U23 players. Clubs and practitioners should consider this gap in order to reduce injury risk (30), increase performance (15, 16) and better prepare players for the required level (11). However, it is important to note that these differences may be attributed to the level of competition and thus further research should aim to consider a wider population across the EPL.

One-Match Weeks

Significant differences were observed in weekly physical outputs across all examined metrics except TD covered, distance covered at speed higher than 85% MSS and ED. The one-match weekly differences between U23 and 1st team players may partly explain the reported variations in training intensity and thus, although not substantiated in our findings, may result in U23 players being under prepared for the demands of the examined 1st team.

Results from the present study identified that during one-match weeks, 1st team and U23 players spend on average 10.1 minutes and 8.0 minutes above MAS, respectively. Maximal Aerobic Speed has been described as an effective way to assess the aerobic energy system in team sports (20). Fitzpatrick et al. (18) illustrated that time spent above MAS has a stronger relationship with changes in aerobic fitness than time spent above generic thresholds. Indeed, running at a speed >100% MAS may be a critical factor when aiming to increase aerobic capacity in U18 youth soccer players (18). Although, caution must be considered when comparing Fitzpatrick et al. (18) findings and our study, as U18 players are a significantly different physical population to the present participants. Importantly, practitioners must understand the benefits of increasing the aerobic capacity of players, with evidence demonstrating greater tolerance to HSR and SD loads (8). Exposing players to time above MAS (>8mins) in training and matches, as demonstrated in the 30-15IFT, has been shown to increase absolute TD, SD and HSR output (18, 31). This may potentially aid the transition to the 1st team for U23 players who are still developing technically, tactically, psychologically and physically.

On average the U23 players cover approximately 26% less HSR during a training week when adopting generic HSR zones, although this increases to 34% when the relative value of 120% MAS is employed. By measuring the distance covered above 120% MAS, it may provide practitioners with distance covered in a more effective training zone for improving aerobic fitness (32). Additionally, by employing 120% MAS, practitioners can be certain that any distance covered above this speed is forcing players to use their anaerobic energy system. Thus, a more effective method of monitoring HSR distance may be to examine each player's ASR.

The current findings suggest that 1st team players cover more SD using generic speed thresholds than U23 players, while U23 players cover more distance at a higher relative intensity. This may be due to the U23 players having slightly lower MSS than the 1st team players. However, the present study did not report statistically significant differences (p=0.36) in MSS between 1st team and U23 players, 9.53 $m \cdot s^{-1} \pm 0.48$ $m \cdot s^{-1}$ and 9.34 $m \cdot s^{-1} \pm 0.44$ $m \cdot s^{-1}$ respectively. Previous evidence suggests that straight-line sprinting is the most frequent powerful action leading to goals and assists in professional football (33). Therefore, improving the peak speed capability of U23 players may arguably allow an easier transition to the examined 1st team by coping with the sprinting demands.

In order to prepare players sufficiently for such physical demands, practitioners are required to schedule exposures to rapid changes of direction and high speed running efforts (9). The first study to examine high risk workload scenarios was conducted in Gaelic football (34). The findings suggested that players who were exposed to >95% of individual peak speed had a reduced injury risk when compared to players who were exposed to lower relative velocities. Similarly, Colby et al. (9) found that low chronic sprint distance and a low number of peak speed exposures during a training week had the greatest association with injury risk in elite Australian Rules Football (AFL) players. Furthermore, exposure to very low chronic sprint distance across the previous four weeks was associated with a 3-fold increase in injury risk (9). While the number of exposures above this threshold have also been previously described as a "speed vaccine" (8), it may be more beneficial to examine the distance covered at very high velocities for players transitioning from the U23 to the 1st team.

Two-Match Weeks

During two-match weeks, no significant differences were observed between 1st team and U23 players for any examined metric. The primary aim of a standardised training week is to optimally perform in matches and improve subsequent recover processes. In elite football, incomplete recovery may increase injury risk and have adverse effects on future performances (35). The training content of such weeks was very similar for both squads with players completing two light training sessions between matches. By individualising the HSR threshold, this metric can be accurately tracked across time to monitor the players specific ''dose'' arising from competitive match-play (5). In the absence of any correction adjustments or modifications, identical external training loads will elicit considerably contrasting internal loads in players with different individual characteristics (36).

Thus, by exposing U23 players to similar 1st team relative physical demands, practitioners may be able to ensure a smooth transition for the developing athlete (37). Having a similar level of physical fitness and being accustomed to covering similar weekly loads, may allow U23 players to focus on other developmental areas such as technical, tactical, or mental. Further research investigating individual drill analysis may also allow practitioners to mirror 1st team training intensity and the absolute load by altering pitch dimensions and changing rules and conditions. While this research focuses on external load, the athletes' perception of internal and external load may also need to be considered during the transition from the U23 to the 1st team.

Limitations

Future research should attempt to include other confounding variables such as, match location, score-line and quality of opposition that may help practitioners better understand in-match differences between groups. The current authors decided not to utilise the equations proposed by Ellens et al. (38) as the exact model intercept values reported represented less than 2% of match values. Thus, the effect of any exact intercept value provided by the transformational work of any distance and distance at 19.8 km - 25.2 km would be small. Future research should also aim to re-test MAS at multiple stages across the season to ensure the individualised speed thresholds accurately represent the players physical characteristics as the season progresses.

Conclusions

Employing individualised HSR and SD thresholds illustrates significant differences in match-play physical outputs, that would not necessarily be identified employing traditional absolute thresholds. Significant differences were evident across all examined metrics except TD during one-match weeks. These differences did not exist during two-match weeks. During one-match weeks, U23 staff should attempt to mirror the 1st team periodisation model to allow players to adapt accordingly to the physical demands. Furthermore, 1st team and U23 sport science staff should align fitness and conditioning ideologies across both teams focusing on 1st team performance and U23 physical development. Finally, exposing U23 players to two-match weeks may be a viable method to emulate 1st team demands and prepare developing players.

References

1. Impellizzeri FM, Marcora SM, Castagna C, Reilly T, Sassi A, Iaia FM, et al. Physiological and performance effects of generic versus specific aerobic training in soccer players. Int J Sports Med. 2006;27(6):483-92.
2. Bradley PS, Archer DT, Hogg B, Schuth G, Bush M, Carling C, et al. Tier-specific evolution of match performance characteristics in the English Premier League: it's getting tougher at the top. J Sports Sci. 2016;34(10):980-7.
3. Buchheit M. Programming high-speed running and mechanical work in relation to technical contents and match schedule in professional soccer. Sport Performance & Science Reports. 2019;64:v1.
4. Akenhead R, Nassis GP. Training Load and Player Monitoring in High-Level Football: Current Practice and Perceptions. Int J Sports Physiol Perform. 2016;11(5):587-93.
5. Abt G, Lovell R. The use of individualized speed and intensity thresholds for determining the distance run at high-intensity in professional soccer. J Sports Sci. 2009;27(9):893-8.
6. Harper DJ, Morin J-B, Carling C, Kiely J. Measuring maximal horizontal deceleration ability using radar technology: reliability and sensitivity of kinematic and kinetic variables. Sports Biomechanics. 2020:1-17.
7. Whaley MH, Brubaker PH, Otto RM, Armstrong LE. ACSM's guidelines for exercise testing and prescription: Lippincott Williams & Wilkins; 2006.
8. Malone S, Owen A, Mendes B, Hughes B, Collins K, Gabbett TJ. High-speed running and sprinting as an injury risk factor in soccer: Can well-developed physical qualities reduce the risk? J Sci Med Sport. 2018;21(3):257-62.
9. Colby MJ, Dawson B, Peeling P, Heasman J, Rogalski B, Drew MK, et al. Improvement of Prediction of Noncontact Injury in Elite Australian Footballers With Repeated Exposure to Established High-Risk Workload Scenarios. Int J Sports Physiol Perform. 2018;13(9):1130-5.
10. Taylor JM, Madden JL, Hunter F, Thorne BJ, McLaren SJ. Mind the “Gap”: A Comparison of the Weekly Training Loads of English Premier League

Academy Soccer Players in Under 23, Under 18 and Under 16 Age-Groups. Journal of Science in Sport and Exercise. 2022.
11. Noon MR, James RS, Clarke ND, Akubat I, Thake CD. Perceptions of well-being and physical performance in English elite youth footballers across a season. J Sports Sci. 2015;33(20):2106-15.
12. Al Haddad H, Simpson BM, Buchheit M, Di Salvo V, Mendez-Villanueva A. Peak match speed and maximal sprinting speed in young soccer players: effect of age and playing position. Int J Sports Physiol Perform. 2015;10(7):888-96.
13. Weston M. Difficulties in determining the dose-response nature of competitive soccer matches. Journal of Athletic Enhancement. 2013;2(1).
14. Hunter F, Bray J, Towlson C, Smith M, Barrett S, Madden J, et al. Individualisation of time-motion analysis: a method comparison and case report series. Int J Sports Med. 2015;36(1):41-8.
15. Castagna C, Impellizzeri F, Cecchini E, Rampinini E, Alvarez JCB. Effects of intermittent-endurance fitness on match performance in young male soccer players. The Journal of Strength & Conditioning Research. 2009;23(7):1954-9.
16. Rampinini E, Bishop D, Marcora SM, Ferrari Bravo D, Sassi R, Impellizzeri FM. Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. Int J Sports Med. 2007;28(3):228-35.
17. Mohr M, Krustrup 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.
18. Fitzpatrick JF, Hicks KM, Hayes PR. Dose-Response Relationship Between Training Load and Changes in Aerobic Fitness in Professional Youth Soccer Players. Int J Sports Physiol Perform. 2018;1-6.
19. Mendez-Villanueva A, Buchheit M, Simpson B, Bourdon PC. Match play intensity distribution in youth soccer. Int J Sports Med. 2013;34(2):101-10.
20. Baker D, Heaney N. Review of the literature normative data for maximal aerobic speed for field sport athletes: a brief review.
21. Winter EM, Maughan RJ. Requirements for ethics approvals. 2009.
22. Coutts AJ, Duffield R. Validity and reliability of GPS devices for measuring movement demands of team sports. J Sci Med Sport. 2010;13(1):133-5.
23. Varley MC, Fairweather IH, Aughey1, Robert J. Validity and reliability of GPS for measuring instantaneous velocity during acceleration, deceleration, and constant motion. J Sports Sci. 2012;30(2):121-7.
24. Beato M, Coratella G, Stiff A, Iacono AD. The Validity and Between-Unit Variability of GNSS Units (STATSports Apex 10 and 18 Hz) for Measuring Distance and Peak Speed in Team Sports. Front Physiol. 2018;9:1288.
25. Scott MT, Scott TJ, Kelly VG. The validity and reliability of global positioning systems in team sport: a brief review. The Journal of Strength & Conditioning Research. 2016;30(5):1470-90.
26. FIFA. Test Report. 2021.
27. Berthon P, Fellmann N, Bedu M, Beaune B, Dabonneville M, Coudert J, et al. A 5-min running field test as a measurement of maximal aerobic velocity. Eur J Appl Physiol Occup Physiol. 1997;75(3):233-8.
28. Knicker AJ, Renshaw I, Oldham AR, Cairns SP. Interactive processes link the multiple symptoms of fatigue in sport competition. Sports med. 2011;41(4):307-28.
29. Rago V, Brito J, Figueiredo P, Krustrup P, Rebelo A. Application of Individualized Speed Zones to Quantify External Training Load in Professional Soccer. J Hum Kinet. 2020;72:279-89.

30. Bowen L, Gross AS, Gimpel M, Li F-X. Accumulated workloads and the acute: chronic workload ratio relate to injury risk in elite youth football players. Br J Sports Med. 2017;51(5):452-9.
31. Redkva PE, Paes MR, Fernandez R, da-Silva SG. Correlation between Match Performance and Field Tests in Professional Soccer Players. J Hum Kinet. 2018;62:213-9.
32. Dupont G, Blondel N, Lensel G, Berthoin S. Critical velocity and time spent at a high level of VO2 for short intermittent runs at supramaximal velocities. Can J Appl Physiol. 2002;27(2):103-15.
33. Faude O, Koch T, Meyer T. Straight sprinting is the most frequent action in goal situations in professional football. J Sports Sci. 2012;30(7):625-31.
34. Malone S, Roe M, Doran DA, Gabbett TJ, Collins K. High chronic training loads and exposure to bouts of maximal velocity running reduce injury risk in elite Gaelic football. J Sci Med Sport. 2017;20(3):250-4.
35. Nedelec M, McCall A, Carling C, Legall F, Berthoin S, Dupont G. Recovery in soccer: part I - post-match fatigue and time course of recovery. Sports Med. 2012;42(12):997-1015.
36. Kavanagh R, Carling C. Analysis of external workload in soccer training and competition: generic versus individually determined speed thresholds. Sci Med Footb. 2019;3(1):83-4.
37. Houtmeyers KC, Jaspers A, Brink MS, Vanrenterghem J, Varley MC, Helsen WF. External load differences between elite youth and professional football players: ready for take-off? Sci Med Footb. 2021;5(1):1-5.
38. Ellens S, Hodges D, McCullagh S, Malone JJ, Varley MC. Interchangeability of player movement variables from different athlete tracking systems in professional soccer. Sci Med Footb. 2022;6(1):1-6.

Table 1: Mean ± SD value for team total match outputs for 1st team and U23 players and effect size (Cohen's d) of difference between squads.

	1st team (Second Spectrum)	95% CI	U23 (GPS)	95% CI	p-value	Effect size
Total Distance (m)	106127 ± 3463	104665 to 107590	108196 ± 3157	106626 to 109767	0.06	0.62
Distance at speed >120% MAS (m)	7513* ± 760	7193 to 7835	7051 ± 720	6693 to 7410	0.04	0.62
High-speed running distance (m)	8118 ± 793	7783 to 8454	7854 ± 640	7536 to 8172	0.15	0.37
Sprint distance (m)	1545 ± 312	1414 to 1678	1572 ± 219	1464 to 1682	0.76	0.10
Distance at speed >85% MSS (m)	320* ± 168	249 to 391	872 ± 208	769 to 976	<0.01	2.92
Time at speed >MAS (min)	52.6 ± 5.5	49.3 to 53.9	51.4 ± 6.6	48.1 to 54.7	0.95	0.03
Distance at speed >MAS (m)	17128 ± 1709	16407 to 17851	16988 ± 1958	16015 to 17962	0.81	0.08
Zone-5 distance (m)	6950 ± 730	6044 to 7858	6724 ± 532	6064 to 7385	0.09	0.35
Distance >120% MAS - <85% MSS (m)	7788* ± 1000	6546 to 9029	6772 ± 794	5786 to 7757	<0.01	1.13
Explosive distance (m)	15165 ± 675	14327 to 16002	14718 ± 698	13851 to 15585	0.08	0.65

* denotes significance ($p<0.05$) for 1st Team vs. U23.

Table 2: Mean ± SD value for average player training and match output for 1st team and U23 players in one-match weeks and effect size (Cohen's d) of difference between squads.

Metric	1st team	95% CI	U23	95% CI	p-value	Effect size
Total Distance (m)	24158 ± 3325	22768 to 25547	24661 ± 2585	23528 to 25794	0.59	0.21
Distance at speed >120% MAS (m)	1395* ± 334	1255 to 1535	1022 ± 315	884 to 1160	<0.01	1.54
High-speed running distance (m)	1476* ± 259	1368 to 1584	1141 ± 265	1025 to 1257	<0.01	1.78
Sprint distance (m)	271* ± 107	226 to 316	187 ± 73	155 to 219	0.01	1.08
Distance at speed >85% MSS (m)	70 ± 43	51 to 88	97 ± 62	70 to 124	0.10	0.87
Time at speed >MAS (min)	10.1* ± 3.1	8.8 to 11.4	8.0 ± 3.3	6.6 to 9.5	0.04	0.82
Distance at speed >MAS (m)	3304* ± 842	2952 to 3656	2633 ± 95	2216 to 3050	0.02	1.10
Zone-5 distance (m)	1163* ± 195	1082 to 1245	954 ± 283	862 to 1046	<0.01	1.48
Distance >120% MAS - <85% MSS (m)	1315* ± 331	1177 to 1453	925 ± 283	801 to 1049	<0.01	1.63
Explosive distance (m)	3208 ± 740	2899 to 3517	3252 ± 416	3070 to 3435	0.81	0.08

* denotes significance ($p<0.05$) for 1st Team vs. U23

Table 3: Mean ± SD value for average player training and match output for 1st team and U23 players in two-match weeks and effect size (Cohen's d) of difference between squads.

Metric	1st team	95% CI	U23	95% CI	p-value	Effect size
Total Distance (m)	23943± 6620	21177 to 26710	25924 ± 7341	22707 to 29141	0.38	0.41
Distance at speed >120% MAS (m)	1396 ± 541	1170 to 1622	1194 ± 526	964 to 1425	0.24	0.51
High-speed running distance (m)	1522 ± 498	1314 to 1730	1333 ± 496	1116 to 1550	0.24	0.52
Sprint distance (m)	297 ± 136	240 to 354	248 ± 126	193 to 303	0.25	0.49
Distance at speed >85% MSS (m)	87 ± 112	40 to 134	133 ± 97	90 to 175	0.17	0.56
Time at speed >MAS (min)	10.2 ± 3.9	8.6 to 11.9	9.2 ± 5.1	7.0 to 11.4	0.48	0.31
Distance at speed >MAS (m)	3395 ± 1200	2894 to 3897	3030 ± 1493	2376 to 3684	0.40	0.42
Zone-5 distance (m)	1187 ± 402	1019 to 1355	1085 ± 391	914 to 1257	0.42	0.35
Distance >120% MAS - <85% MSS (m)	1350 ± 495	1143 to 1556	1061 ± 457	861 to 1262	0.06	0.80
Explosive distance (m)	3215 ± 1032	2783 to 3646	3424 ± 999	2986 to 3862	0.52	0.28

* denotes significance ($p<0.05$) for 1st Team vs. U23

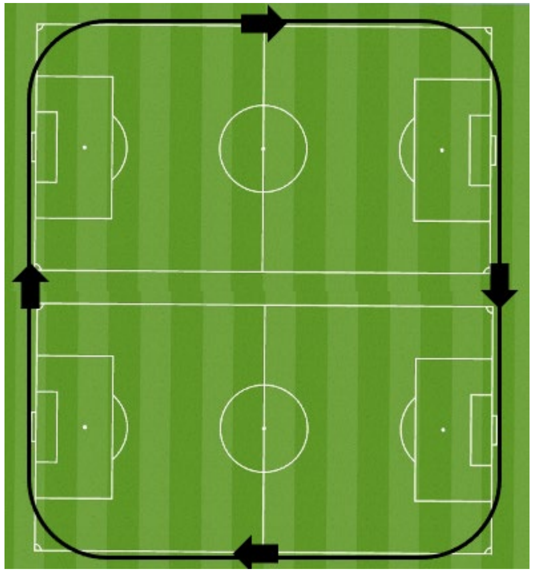

Figure 1: The MAS testing track design