Comparative analysis of the anaerobic speed reserve in professional soccer: 1st team vs. Development team

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Headline

The anaerobic speed reserve (ASR), representing the difference between maximal aerobic speed (MAS) and maximal sprinting speed (MSS), has been proposed as an important consideration for practitioners working with team sport athletes and provides insight into an athletes tolerance to high intensity running (1-2). Central to the utility of this concept in a practical setting is the ability to estimate an athletes locomotor profile in relation to their biological predisposition (muscle fibre typology) with differences used to guide training decisions. Indeed, practical guidance for locomotor profiling through the examination of ASR and its related parameters currently exists (1) and is outlined in Table 1. Despite this, practitioners working with small, single-squad data sets are faced with challenges when sub-grouping ASR parameters by calibre (high/normal/low) which may limit the safe and effective prescription of exercise intensity, drill design and understanding the variability of locomotor profile's within squads.

Aim

The aim of this study was to compare the locomotor profile (MAS, MSS and ASR) of 1st team and development squad (u23s) players within the same professional soccer club. Additionally, this study aimed explore a quantile-based method of sub-grouping players by calibre and examine the variability of locomotor profiles which may influence the ability to optimise playing positions and execute specific playing styles.

Methods

Participants

Fourteen elite senior (age: 25 ± 4.1 years; height: 182.3 ± 5.1 cm; body mass: 80.1 ± 5.2 kg; 5 Defenders, 5 Midfielders, 4 Attackers) and 14 elite development squad (age: 19.2 ± 1.1 years; height: 180.2 ± 6.1 cm; body mass: 76.1 ± 7.8 kg; 5 Defenders, 5 Midfielders, 4 Attackers) players from a Scottish Premiership club agreed to take part in the present study. Data were collected in line with the football clubs' daily practices which all conformed to the declaration of Helsinki.

Procedures

All trials were performed during the in-season period (September) and followed a standardised warm-up. To assess MAS (Endurance), a 1000m time trial was performed to which all players were previously accustomed to. The methodology and validity of the 1000m time trial (10 x 100m shuttle run) has been outlined previously (3) and has been used in international football to assess aerobic performance (4). Maximal sprinting speed (Speed) was assessed during a maximal 40m sprint using GPS technology (Catapult, S7). In accordance with previous research, ASR was defined as the difference between MAS and MSS (in metres per second [m/s]) (5). All trials were performed in the morning on artificial turf (conditions: still, 10-13°C) and followed a standardised breakfast.

Statistical Analysis

Descriptive statistics are reported as group mean score ± standard deviations (SD). All parameters were compared between squads via standardised differences in the mean (effect size: Cohen's d) with 95% confidence intervals applied. To interpret whether differences in MAS and MSS between squads were practically meaningful, the raw effect was compared against a performance-related practically important change (Table 2). To provide a threshold for sub-grouping athletes by calibre, 25th and 75th percentile values were also calculated. These threshold values were selected pragmatically to represent the outer ranges (high/low) of performance capability and have previously been used to calculate small, medium and large threshold values (6). The coefficient of variation was calculated to explore the within-squad variability of locomotor profiles which may be pertinent when assessing the overall physical capability of the squad to cover certain positions and execute specific tactical systems. Uncertainty in our estimates is shown via 95% confidence intervals (95% CI) and data were analysed using Jamovi (The jamovi Project. n. d. *jamovi* 2.3.21).

Results

Raw data, probability density, and boxplots of MAS, MSS, and ASR per playing squad are visualised via Raincloud plots (Figure 1) (7).

MAS

Greater MAS performance, approaching the threshold for practical importance (0.18 m/s) was observed in the 1st team squad when compared with the development squad (Table 3). Variability in MAS, as described by the coefficient of variation was 4.6% (95% CI 3.4%, 7.6%) and 2.6% (95% CI 2.0%, 4.3%) for the 1st team and development squad, respectively. 25th and 75th percentile values were 5.1 m/s and 5.3 m/s for the 1st team squad and 4.9 m/s and 5.1 m/s for the development squad, respectively (Figure 1).

Table 1. Guidance for estimating athlete locomotor profile sub-group (from Sandford et al 2021).

	Speed Profile	Hybrid Profile	Endurance Profile
Locomotor Profile	Low MAS High MSS	Moderate MAS Moderate MSS	High MAS Low MSS
Anaerobic Speed Reserve	High	Moderate	Small

Table 2. Practically important change values for locomotor profiling parameters.

Locomotor Parameter Change Value	Practically Important Change	Description
MAS	0.2 m/s	Mean difference between centre midfielder and central defender MAS scores*
MSS	0.1 m/s	Represents an advantage of 0.2 metres when evading/denying an opponent following 2 seconds at maximum velocity

*Respectively the highest and lowest positional MAS scores

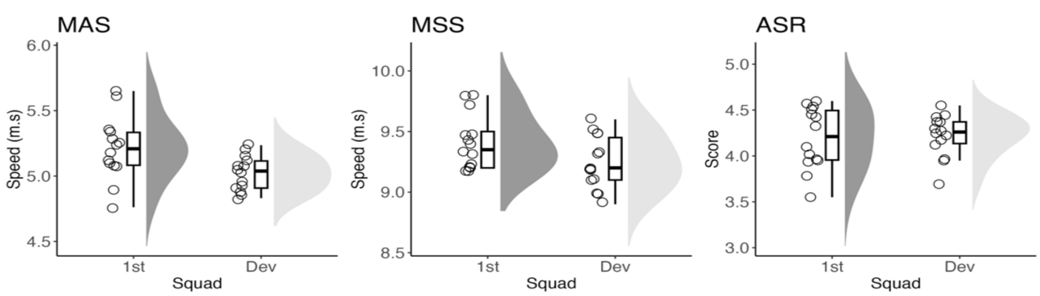

Fig. 1. Raincloud plots for MAS, MSS and ASR

Table 3. Differences in locomotor parameters between 1st team and development squad. Standardised effect size (Cohen's d) with qualitative inference and raw effect with minimum practically important change inference.

Locomotor Parameter	Effect Size (95% CI)	Qualitative Inference (Distribution-based)	Raw Effect	Practical Inference (Criteria-based)
MAS	0.97 (0.13, 1.79)	1st Team Moderately Higher	0.18 m/s	Approaching threshold
MSS	0.74 (-0.06, 1.52)	1st Team Moderately Higher	0.17 m/s	Exceeds threshold
ASR	-0.05 (-0.79, 0.69)	Trivial difference	-0.01 m/s	n/a

MSS

Greater MSS performance, exceededing the selected threshold for practical importance (0.17 m/s) was observed in the 1st team squad when compared with the development squad (Table 3). The variability in MSS was 2.4% (95% CI 1.8%, 3.9%) and 2.4 % (95% CI 1.7%, 3.8%) for the 1st team and development squad, respectively. 25th and 75th percentile values were 9.2 m/s and 9.5 m/s for the 1st team squad and 9.1 m/s and 9.4 m/s for the development squad, respectively (Figure 1).

ASR

There were no between-squad differences in ASR (Table 3). The variability in ASR was 8.0% (95% CI 5.6%, 13.1%) and 5.4% (95% CI 4.0%, 8.9%) for the 1st team and development squad, respectively. 25th and 75th percentile values were 4.0 m/s and 4.5 m/s for the 1st team squad and 4.1 m/s and 4.4 m/s for the development squad, respectively (Figure 1).

Discussion

The main finding of this exploratory analysis was that while 1st team players demonstrated superior MAS and MSS capability compared to the development squad, ASR was comparable indicating the differences in locomotor parameters (MAS and MSS) were proportionate between squads. Practically, it has been suggested that high intensity running performance may be limited by how much of the ASR is used rather than the intensity relative to MAS (1). Data from highly-trained youth players has previously revealed supra-maximal running performance is largely correlated to aerobic and MSS capability (8). This data indicates the prescription of the same exercise intensity relative to ASR would be appropriate for both squads. Previous research has highlighted in-season changes in MAS and MSS are associated with game-related sprint activities in youth soccer (9).

For all parameters, within-squad variability was highest in the 1st team squad for ASR (CV%, 8%). This appears to be driven largely by variation in MAS, where CV% was 4.6% compared with 2.6% among development players while variation in MSS was 2.4% for both squads. Greater within-squad heterogeneity in ASR should allow teams more tactical flexibility (style of play) alongside the ability to logically select players with optimal locomotor profiles for each position. Positional demands for high intensity running have been found to vary significantly during match-play (10) and training drills (11) highlighting the requirement for varied locomotor profiles within teams. A more homogenous ASR profile within the development squad, indicative of less physiological diversity, may reflect the profile of players graduating from academy systems and the trend for 1st team squads to adopt external recruitment strategies. Comparable data in professional soccer is elusive and it remains to be determined whether the variability observed in this data is normal or indeed optimal in wider soccer populations.

In this exploratory study, 25th and 75th percentiles were selected to stratify players by calibre for each parameter. While these threshold values were selected pragmatically to capture the outer ranges (high/low) of performance capability, previous research has applied broader ranges (33rd and 66th percentile) (2) and practitioners are encouraged to consider their own population and sample sizes. In addition, practitioners should decide whether athlete calibre should be gauged internally from squad or club benchmarks or whether external reference values are more appropriate. For example, is 9.5 m/s (75th percentile for 1st team MSS) representative of elite level speed in professional soccer and therefore a suitable proxy for identifying players with fast twitch muscle fibre dominance.

Table 4. Individual player data (1st team) for each ASR parameter and appropriate locomotor profile grouping.

Name	Position	MAS (m/s)	MSS (m/s)	ASR (m/s)	Locomotor Profile
Player 1	FB	5.6	9.4	3.8	Endurance
Player 2	CAM	5.6	9.2	3.6	Endurance
Player 3	CB	4.8	9.3	4.5	Hybrid
Player 4	CB	5.2	9.2	4.0	Endurance
Player 5	CAM	5.3	9.3	4.0	Hybrid
Player 6	CDM	5.2	9.2	4.0	Endurance
Player 7	CAM	5.1	9.7	4.6	Speed
Player 8	CF	5.1	9.4	4.3	Hybrid
Player 9	FB	5.1	9.2	4.1	Hybrid
Player 10	WA	4.9	9.5	4.6	Speed
Player 11	CDM	5.3	9.2	3.9	Endurance
Player 12	CF	5.1	9.5	4.4	Hybrid
Player 13	FB	5.3	9.8	4.5	Speed
Player 14	WA	5.3	9.8	4.5	Speed

Red = high (≥75th percentile): Amber = normal (26th – 74th percentile): Green = low (≤25th percentile); CB = Centre Defender, FB = Full Back, CDM = Central Defensive Midfielder, CAM = Central Attacking Midfielder, WA = Wide Attacker, CF = Centre Forward.

Practical implications

- The anaerobic speed reserve can be calculated using a 1000m TT (MAS) and 40m sprint (MSS) with minimal equipment and without being over-bearing, from a time-perspective, to other aspects of the training programme.
- To accurately interpret locomotor profiles, practitioners should be confident MAS and MSS performance are close to the limits of each players capacity. For example, despite similar ASR profiles, 1st team players demonstrated higher MAS and MSS perhaps indicating room for headway, physiologically, within the development squad.
- In this data, the difference between the 25th and 75th percentile for MAS (0.2 m/s) and MSS (0.3 m/s) reached or exceeded their respective practically important change values indicating that these grouping thresholds provided a distinction between players that was practically meaningful.
- By considering all locomotor parameters, thresholds can be used to estimate each players biological suitability to different training approaches (Table 4).
- The capability of a team to optimally adopt a high intensity style of play may be assessed by examining the within-squad variability of locomotor profiles. In this exploratory data, locomotor profile variability, as described by CV% ranging from 2.4 - 8% between parameters, translated to 5x*Hybrid*, 5x*Endurance* and 4x*Speed* profiles within the 1st team squad overall.

Limitations

- A limitation of the present study is the small sample size, although this is common in studies of players at a professional level.
- As MAS is typically assessed over longer distances (≥1200m) in order to prolong the oxidative demands, in the current analysis greater MAS values and subsequently reduced ASR would be expected.
- As such, where alternative protocols are preferred, practitioners should approach the transferability of this data with caution.
- Given this study involved a single trial, future research should focus on season-long fluctuations of each parameter in response to training and match-play and the influence on ASR.

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