The impact of locomotor characteristics on jumping ability and VO2max in professional soccer players

El impacto de las características locomotoras en la capacidad de salto y el VO2max en futbolistas profesionales

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How to cite in APA

Falces Prieto, M., González Fernández, F. T., Iglesias Garcia, F. J., López Mariscal, S., & Izquierdo Velasco, J. M. (2025). The impact of locomotor characteristics on jumping ability and VO2max in professional soccer players. *Retos, 70*, 859–869. https://doi.org/10.47197/retos.v70.114470

Abstract

Introduction and Objective. The purpose of the study was to analyze the differences in locomotor profiles in professional football players and their relationship with performance in jumping and maximum oxygen consumption (VO_2max).
Methodology. 23 players from the Second Division of the Belgian league (27.6 ± 4.2 years old; 182.5 ± 6 cm; 77.29 ± 7.16 kg) performed the countermovement jump test (CMJ), a 30-meter sprint and the 30-15 IFT test to estimate VO_2max. Players are classified in Speed, Hybrid and Endurance profiles.
Results. The descriptive analyzes showed the highest values of maximum aerobic speed (VAM) in the Endurance profile (5.98 ± 0.29), maximum sprint speed (MSS) in the Speed profile (9.59 ± 0.49), anaerobic speed reserve (ASR) (3.96 ± 0.21) and CMJ also in the Speed profile (40.55 ± 5.97), while the VO_2max was higher in the Resistance profile (58.57 ± 2.95). The CMJ showed a significant contribution to the variation of the VAM in resistance players (Spearman's rho = -0.804; p = 0.029), and in the Velocity group the VO_2max was strongly associated with the VAM (Spearman's = 0.872; p = 0.054) and the MSS (Spearman's = 0.900; p = 0.083).
Conclusions. The results suggest that locomotor profiles are linked to specific neuromuscular and aerobic attributes. Individualized training based on locomotor characteristics can improve performance by enhancing specific strengths. Additional investigations are recommended to examine the long-term effects of personalized interventions on physical profiles and football performance.

Keywords

V02max; soccer; jumping ability; performance; physical fitness.

Resumen

Introducción y Objetivo. El propósito del estudio fue analizar las diferencias de los perfiles locomotores en futbolistas profesionales y su relación con el rendimiento en el salto y el consumo máximo de oxígeno (VO_2max).
Metodología. 23 jugadores de la Segunda División de la liga belga (27.6 ± 4.2 años; 182.5 ± 6 cm; 77.29 ± 7.16 kg) realizaron la prueba de salto con contramovimiento (CMJ), un sprint de 30 metros y el test 30-15 IFT para estimar el VO_2max. Los jugadores se clasificaron en perfiles de Velocidad, Híbrido y Resistencia.
Resultados. Los análisis descriptivos mostraron los valores más altos de velocidad aeróbica máxima (VAM) en el perfil de Resistencia (5.98 ± 0.29), velocidad máxima de sprint (MSS) en el perfil de Velocidad (9.59 ± 0.49), reserva de velocidad anaeróbica (ASR) (3.96 ± 0.21) y CMJ también en el perfil de Velocidad (40.55 ± 5.97), mientras que el VO_2max fue superior en el perfil de Resistencia (58.57 ± 2.95). El CMJ mostró una contribución significativa a la variación de la VAM en jugadores de resistencia (Spearman's rho = -0.804; p = 0.029), y en el grupo de Velocidad el VO_2max se asoció fuertemente con la VAM (Spearman's = 0.872; p = 0.054) y la MSS (Spearman's = 0.900; p = 0.083).
Conclusiones. Los resultados sugieren que los perfiles locomotores están vinculados a atributos neuromusculares y aeróbicos específicos. El entrenamiento individualizado basado en las características locomotoras puede mejorar el rendimiento al potenciar las fortalezas específicas. Se recomiendan investigaciones adicionales para examinar los efectos a largo plazo de las intervenciones personalizadas en los perfiles físicos y el rendimiento futbolístico.

Palabras clave

VO2max; fútbol; capacidad de salto; rendimiento; estado físico.

Introduction

Soccer is characterized as an intermittent sport, where phases of low to moderate exertion are interspersed with periods of maximal effort (Benítez-Jiménez et al., 2020; Kaplánová et al., 2020). The physical demands of the game involve a variety of high-intensity actions, such as sprinting, rapid directional changes, jumping, and acceleration/deceleration (Andrzejewski et al., 2013; Martínez-Cabrera et al., 2021). Given the rigorous nature of soccer, it is essential for players to possess well-developed aerobic and anaerobic energy systems to sustain performance throughout the 90 minutes of play, plus any additional time (Baker et al., 2025). Consequently, the primary goal for fitness coaches and sports scientists in soccer is to ensure that players can maintain the intensity of the game for extended durations (Silva et al., 2022b). To achieve this, training methodologies have been designed to enhance the physical attributes of soccer players (Oliva-Lozano et al., 2020). Furthermore, the training regimens implemented during both pre-season and competitive periods play a crucial role in achieving optimal performance outcomes throughout the season, highlighting the importance of effective evaluation and planning (Papaevangelou et al., 2012). Recent scientific literature has increasingly focused on these two locomotor speeds due to their predictive value for high-intensity exercise performance (Buchheit et al., 2014). In addition to MSS and MAS, it is crucial to consider anaerobic reserve velocity (ASR), which is calculated as the difference between MAS and MSS (Sandford et al., 2019). ASR is recognized as an important metric for practitioners working with team sport athletes, as it provides valuable insights into an athlete's tolerance for high-intensity running (Clancy et al., 2023). By analyzing these variables, practitioners can effectively identify and classify players' locomotor profiles, which can be categorized as follows according to Sandford et al., (2021): i) speed profile [low MAS/high MSS/large ASR]; ii) hybrid profile [moderate MAS/moderate MSS/moderate ASR]; and iii) endurance profile [high MAS/low MSS/small ASR]. The term "locomotor profile" suggests the relationship of cardiorespiratory measures with the locomotor demands attained during those measures, in which the MAS is the main outcome associated with the concept (Buchheit et al., 2021). Furthermore, a larger the ASR has been associated with fast-twitch muscle fibers, while moderate ASR correlates with intermediate fibers, and finally, small ASR is linked to slow-twitch fibers (Karp, 2001). By evaluating our players and understanding their locomotor profile, we can understand their competitive profile and physiological and psychological requirements during periods of physical training and competition, in order to maximize adaptation to training and minimize overtraining and injury risk (Di Credico et al., 2021). This is why this study is so important for the application of this assessment in professional and/or youth football.

Considering the competitive profile of soccer, where players frequently engage in jumps and sprints with minimal recovery time, underscoring the importance of anaerobic training capacity (Da Silva et al., 2019). Actions such as jumping, changing direction, and sprinting during counterattacks highlight the necessity of anaerobic power in soccer (Buchheit et al., 2014). These high demands can lead to alterations in the musculoskeletal, nervous, metabolic, and immune systems, resulting in fatigue among players (Falces-Prieto et al., 2023). Consequently, soccer players require significant lower body strength (Quagliarella et al., 2011). Many professional soccer teams utilize the CMJ as a tool for monitoring performance changes and assessing neuromuscular readiness in athletes (Alves et al., 2022; Falces-Prieto et al., 2021). The CMJ has been shown to have a positive correlation with maximum speed during sprints of 30-60 meters and with efficiency in directional changes (Oleksy et al., 2024). Additionally, the stretch-shortening cycle involved in the CMJ, along with the muscle power demonstrated in vertical jumps, may help explain the ability to achieve peak efforts during the final stages of intermittent endurance testing (Silva et al., 2022b).

Knowing the relationship between CMJ and endurance test results, it is important to understand the significance of VO_2max in soccer, as boosting this variable is a crucial strategy for individual fitness (Nugraha et al., 2024; Silva et al., 2011; Ziogas et al., 2011). Players with elevated VO_2max levels tend to exhibit greater engagement in high-intensity activities and sprinting, as well as improved recovery between intense efforts (Quagliarella et al., 2011). Furthermore, higher aerobic capacity facilitates quicker recovery from explosive, high-intensity intermittent movements by enhancing the aerobic response, improving lactate clearance, and promoting phosphocreatine (PCr) regeneration. This increased aerobic capacity may also be essential for optimizing anaerobic efficiency during such efforts (Silva et al., 2022b). In fact, in recent years, various field tests have been developed to evaluate VO_2max (Sánchez-Oliva et al., 2014). One widely used test among soccer players is the 30–15 Intermittent Fitness Test

(30–15 IFT) (Buchheit, 2008). The 30–15 IFT serves to standardize training intensity while implementing high-intensity interval training (Di Credico et al., 2021; Silva et al., 2022a). Moreover, by combining the final velocity achieved in the 30–15 IFT with the MSS obtained from speed tests (Silva et al., 2022a), practitioners can calculate the ASR of players and categorize them into specific locomotor profiles (Sandford et al., 2021).

Understanding the interplay between VO_2max and locomotor profiles is vital, as knowledge about the relationships between these factors, along with the CMJ and other physical qualities, is still developing (Silva et al., 2022b). Moreover, combining the final velocity at 30-15 IFT and the MSS it is possible to obtain the ASR of the players and classify them into their locomotor profile (Sandford et al., 2021). Following the line of Kibler et al., (1992), the importance of this study is that understanding the profile of our players and being able to create maintenance conditioning programs that extend throughout the season can be important for maintaining physical condition throughout the season. This understanding can assist coaches in specifying and individualizing training processes, allowing for the classification of players based on their unique skills to sustain and maintain match intensity. Therefore, the purpose of this study was two-fold: (i) to calculate the differences of locomotor profiles (Speed, Hybrid and Endurance) in professional football players and (ii) to test the interaction effect of these locomotor profiles on the variables of jumping performance and maximum oxygen consumption and high intensity running tolerance parameter (MAS, MSS and ASR). This study tests the hypothesis that professional soccer players with different locomotor profiles (speed, hybrid, and endurance) will show significant differences in their explosive force, as measured by the countermovement jump (CMJ), and in their aerobic capacity, as measured by VO_2max. Specifically, we hypothesize that within each locomotor profile, CMJ performance will be significantly associated with maximal aerobic speed (MAS), maximal sprinting speed (MSS), and the anaerobic speed reserve (ASR), reflecting the interaction between explosive power and high-intensity running capacity.

Method

This investigation employed a prospective cohort design, involving players from the same team without any randomization. To categorize players into distinct subgroups based on their performance caliber—specifically Speed, Hybrid, or Endurance Profiles—thresholds were established using the 25th and 75th percentile values. The study focused on Belgian Professional Soccer Players competing in the 2nd Division. Data collection occurred in July (between 15th to 31st), coinciding with the onset of the 2024/2025 pre-season. During the first week, the players' jump capacity was assessed through the CMJ test (15th of July). The second week involved a speed assessment to determine Maximum Sprint Speed (MSS) (22th of July), while the third week (29th of July) included the 30-15 Intermittent Fitness Test (30-15 IFT) to evaluate the players' Velocity at Maximum Aerobic Speed (VIFT [MAS]). All players became familiar with the test exercises. During this period, the training consisted of strength and prevention training in the gym before training. On the field, physical conditioning circuits and specific technical and tactical exercises were performed. In addition, two friendly matches were played on July 24th and 31st.

Participants

A total of 23 professional soccer players were recruited for this study, with an average age of 27.6 ± 4.2 years, an average height of 182.5 ± 6 cm, and an average weight of 77.29 ± 7.16 kg. The sample, according to playing position, was made up of Central Defenders (N=4), Full Backs (N=4), Midfielders (N=6), Wingers (N=4) and Forwards (N=5). All participants were members of the same team competing in the 2nd Division of the Belgian League System (Challenger Pro League), which is governed by the Royal Belgian Football Association. 5 youth players and 4 professional players who changed teams during the transfer window were not taken into account. The inclusion criteria were the following: Players with professional contracts, players who reported not having vision problems, not having partial/chronic injuries and not having neuropsychological problems that affected the experiment and, in addition, playing licensed soccer for ~5 years. All participants had experience performing the CMJ, Speed and 30-15 IFT test. None of the analyzed participants presented previous injuries that could compromise the test. Participants were thoroughly briefed on the study procedures and provided their informed consent prior to participation. The research adhered to the ethical guidelines outlined in the Helsinki Declaration for human research and was approved by the ethics committee of the Universidad Isabel I (code: PI-008).

Procedure

Countermovement Jump

The Countermovement Jump (CMJ) was assessed using portable, uniaxial dual force plates (ForceDecks, FDLite V.2, VALD®, Brisbane, Australia). These force plates recorded data at a frequency of 1000 Hz, with a systematic error ranging from 0 to 3 N (equivalent to 0.3–0.5% of the load), which was deemed negligible across all measured load levels (Collings et al., 2024). The system was connected to a MacBook Pro (macOS Sur 11.1) for subsequent data analysis using Microsoft Excel®. Testing took place in a gym environment maintained at approximately 20ºC, with participants dressed in sports attire and running shoes. Before the test, the players performed 10-minute warm-up based on: free joint and muscle mobility (3 min), skipping (2x30seconds), gluteal heel (2x30 seconds), squats with extended arms (2x10 repetitions), continuous vertical jumps (6 jumps with the CMJ execution). Between the warm-up and the test, 2 minutes passed, to avoid residual fatigue from the warm-up. After, each player performed the CMJ test three times on a force plates, with a 20-second recovery period between attempts to mitigate fatigue effects. The highest jump recorded in centimeters (cm) was used as the final measurement (Falces-Prieto et al., 2022).

Maximal Speed Sprint

MSS was assessed through a 30-meter linear sprint test utilizing an electronic timing gate system (Smartspeed, Fusion Sport, QLD, Australia). Timing gates were adjusted to an appropriate hip height as per the mean stature of the sample group. The players stood 1 m behind the starting line, with one foot forward, in an upright position and looking straight ahead. The test was also integrated with a Global Positioning System (GPS). Each player was equipped with a GPS device (WIMU PRO®, RealTrack Systems, Almería, Spain), which featured a 10-Hz GPS and a 100-Hz triaxial accelerometer (Bastida-Castillo et al., 2028). Players were required to wear a GPS unit fitted on the upper back of each player using a neoprene harness. All the units were activated more than 20 min before training, allowing the acquisition of satellite signals (Falces-Prieto et al., 2021; Palacio et al., 2024). The test started with a standard 10 min warm-up, which included dynamic stretching of the lower and upper limbs, joint mobility, continuous running and 3 series of 30 m runs at increasing velocity. Participants completed two 30-meter sprints, allowing for a 2-minute passive recovery between attempts. The MSS recorded during each trial was collected, and the best performance was selected for further data analysis. The sprint test was conducted on natural grass, with players consistently starting with their preferred leg forward and wearing standard competition footwear and with an ambient temperature of approximately 30ºC.

VIFT at 30-15 Intermittent Fitness Test and Anaerobic Speed Reserve (ASR)

The 30-15 Intermittent Fitness Test was conducted by participants following the protocol established by Buchheit (2008). This test involves performing shuttle runs for 30 seconds, followed by 15 seconds of passive recovery. It begins at an initial speed of 8 km/h, with the velocity increasing by 0.5 km/h at the end of each 30-second stage. Players were marked each time they failed to reach the designated line in time with the audio cue. If a player failed to complete the required distance three consecutive times, the last correctly achieved speed was recorded for subsequent analysis. The test was conducted on natural grass, and participants wore standard competition footwear and with an ambient temperature of approximately 32ºC. The test itself, starting at 8 km/h, served as a progressive warm-up. The final velocity attained at the last completed stage was used to determine the final velocity [VIFT (MAS in the original proposal)]. To estimate VO2Max, the following formula was applied (Buchheit, 2008):

$$VO_2max = 28.3 - (2.15 \times G) - (0.741 \times A) - (0.0357 \times W) + (.0586 \times A \times VIFT) + (1.03 \times VIFT).$$

Variables: G: Gender (one man; two women); A: age; W: weight; VIFT: final speed reached.

The anaerobic speed reserve was calculated as the difference between MSS and VIFT with the following equation of Silva et al., (2022b): ASR (m/s) = MSS (m/s) – MAS (m/s)

Data analysis

To establish thresholds for categorizing players into Speed, Hybrid, or Endurance profiles, the 25th and 75th percentile values were calculated in accordance with the methodology outlined by Clancy et al. (2023). These thresholds were strategically selected to represent the extremes of performance capacity (high, moderate and low) and have been previously utilized to determine small, medium, and large effect sizes (Swinton et al., 2022). Additionally, the classification of players into their respective locomotor profile subgroups (Speed, Hybrid, and Endurance) was conducted following the guidelines set forth by Sandford et al., (2021).

Descriptive statistics were reported as mean scores ± standard deviations (SD). The relationships between high intensity running tolerance parameter (MAS, MSS and ASR) and jumping performance (CMJ) or maximum oxygen consumption (VO_2max) for each profile group (Speed, Hybrid and Endurance) were evaluated using Spearman's rho correlation. The strength of these relationships was evaluated according to the following criteria: 0.0-0.20 (insignificant), 0.21-0.40 (weak), 0.41-0.60 (moderate), 0.61-0.80 (strong) and 0.81-1.00 (very strong) (Prion & Haerling, 2014). In addition, effect sizes (ES) were calculated and were interpreted as <0.2 (trivial), 0.2-0.5 (small), 0.5-0.8 (moderate), 0.8-1.3 (high) and >1.3 (very high) (Cohen, 2013). The $p \leq 0.05$ was regarded as significant, and the confidence interval was set at 95%. All statistical analyses were performed using JASP 0.16.3.0 software (University of Amsterdam, Amsterdam, Netherlands).

Results

Table 1 shows the individual player profiles based on high-intensity running tolerance parameters. It indicates that 5 players were classified with a speed profile, 10 players with a hybrid profile, and 7 players with an endurance profile. Additionally, individual data for CMJ and VO_2max are also presented.

Table 1. Individual player data for each high intensity running tolerance parameter, CMJ and VO2Max, and appropriate locomotor profile

Player	Position	MAS (m/s)	MSS (m/s)	ASR (score)	Profile	CMJ (cm)	VO_2max (ml/kg/min)
Player 1	Central Defender	5.97	10.03	4.06	Speed	42.4	58.93
Player 2	Central Defender	6.11	9.92	3.81	Speed	45.4	57.63
Player 3	Striker	5.42	9.73	4.31	Speed	48.2	52.1
Player 4	Midfielder	5.56	9.35	3.80	Hybrid	33	57.95
Player 5	FullBack	5.69	9.31	3.61	Hybrid	38.6	57.13
Player 6	Winger	5.97	9.29	3.32	Hybrid	42.4	59.23
Player 7	Striker	5.42	9.29	3.88	Speed	34.3	56.59
Player 8	Striker	5.42	9.17	3.75	Hybrid	36.8	50.17
Player 9	Winger	5.42	9.14	3.73	Hybrid	33.2	55.1
Player 10	Midfielder	5.97	9.10	3.13	Endurance	36.5	59.38
Player 11	Midfielder	5.28	9.08	3.80	Speed	36	51.5
Player 12	Midfielder	6.39	8.83	2.44	Endurance	33.5	63.61
Player 13	Midfielder	6.11	9.02	2.91	Endurance	32.6	60.98
Player 14	FullBack	5.69	8.99	3.29	Hybrid	44.6	57.79
Player 15	Midfielder	5.42	8.94	3.53	Hybrid	37.2	58.48
Player 16	Central Defender	5.69	8.94	3.24	Hybrid	36.6	59.44
Player 17	Winger	5.97	8.93	2.96	Endurance	33.5	55.63
Player 18	Striker	5.56	8.92	3.36	Hybrid	34.8	56.95
Player 19	Central Defender	5.69	8.89	3.19	Endurance	38.2	58.96
Player 20	FullBack	5.56	8.88	3.33	Hybrid	49.4	55.11
Player 21	FullBack	5.56	8.86	3.31	Hybrid	36.4	57.47
Player 22	Winger	5.83	8.86	3.03	Endurance	35.6	55.95
Player 23	Striker	5.97	8.39	2.42	Endurance	34.3	56.35

Notes: Red = high (≥75th percentile): Amber = normal (26th – 74th percentile): Green = low (≤25th percentile); MAS, maximal aerobic speed; MSS, maximal sprinting speed; ASR, anaerobic speed reserve; CMJ, counter movement jump; VO_2max, Maximum Oxygen Consumption

Once the groups were configured by profiles, table 2 shows the descriptive results (means and SD´s). The highest values in each parameter were: MAS (endurance profile, 5.98 ± 0.29), MSS (speed profile, 9.59 ± 0.49), ASR (3.96 ± 0.21), CMJ (speed profile, 40.55 ± 5.97) and VO_2max (endurance profile, 58.57 ± 2.95).

Table 2. Global descriptive statistics (mean ± standard deviations) for each locomotor profile and high intensity running tolerance parameter

Profile	MAS (m/s)	MSS m/s	ASR (score)	CMJ (cm)	VO_2max (ml/kg/min)
Speed (n=5)	5.62 ± 0.37	9.59 ± 0.49	3.96 ± 0.21	40.55 ± 5.97	55.18 ± 3.35
Hybrid (n=11)	5.59 ± 0.16	9.07 ± 0.18	3.46 ± 0.21	37.90 ± 5.05	56.68 ± 2.61
Endurance (n=7)	5.98 ± 0.29	8.85 ± 0.22	2.83 ± 0.31	34.79 ± 1.98	58.57 ± 2.95
All (n=23)	5.71 ± 0.29	9.11 ± 0.37	3.33 ± 0.47	37.43 ± 4.97	56.90 ± 3.01

Notes: MAS, maximal aerobic speed; MSS, maximal sprinting speed; ASR, anaerobic speed reserve; CMJ, counter movement jump; VO_2max, Maximum Oxygen Consumption

Table 3 shows the associations between the parameters of high intensity running tolerance and both jumping ability and maximal oxygen consumption for each locomotor profile. No statistical differences were found in the case of Speed and Hybrid profiles ($p > 0.005$). However, "very high" strength relations were found between VO_2max with MAS (Spearman´s rho = 0.872, very strong; p = 0.054; ES = 0.610, moderate) and MSS (Spearman´s rho = 0.900, very strong; p = 0.083; ES = 0.613, moderate) for Speed group players. Endurance profile reported negative significant differences correlations between CMJ and MAS (Spearman´s rho = -0.804, strong; p = 0.029; ES = 0.473, small).

Table 3. Association results between the parameters of high-intensity running tolerance and both jumping ability and maximal oxygen consumption for each locomotor profile.

Locomotor profile group	Variable		MAS	MSS	ASR
Speed	CMJ	Spearman's rho	0.410 (moderate)	0.500 (moderate)	0.500 (moderate)
		ES	0.588 (moderate)	0.591 (moderate)	0.591 (moderate)
	VO_2max	Spearman's rho	0.872 (very strong)	0.900 (very high)	0.300 (small)
		ES	0.610 (moderate)	0.613 (moderate)	0.585 (moderate)
Hybrid	CMJ	Spearman's rho	0.422 (moderate)	-0.118 (insignificant)	-0.436 (moderate)
		ES	0.343	0.336	0.343
	VO_2max	Spearman's rho	0.574 (moderate)	0.091 (insignificant)	-0.500 (moderate)
		ES	0.347 (small)	0.335 (small)	0.344 (small)
Endurance	CMJ	Spearman's rho	-0.804* (strong)	0.018 (insignificant)	0.721 (strong)
		ES	0.473 (small)	0.448 (small)	0.468 (small)
	VO_2max	Spearman's rho	0.630 (strong)	0.107 (insignificant)	-0.179 (insignificant)
		ES	0.464 (small)	0.450 (small)	0.451 (small)

Notes: MAS, maximal aerobic speed; MSS, maximal sprinting speed; ASR, anaerobic speed reserve; CMJ, counter movement jump VO_2max, Maximum Oxygen Consumption; ES, effect size; *$p \leq 0.05$

Discussion

The first aim of this study was to calculate the differences in locomotor profiles (Speed, Hybrid and Endurance) among professional soccer players and, the second and aim purpose was to examine the association effects of these profiles on jumping performance and VO_2max and high intensity running tolerance parameter (MAS, MSS and ASR). The hypothesis of this study is partially fulfilled due to the results show that only Speed and Endurance players exhibit relevant associations in VO_2max and CMJ, respectively, with a high intensity running tolerance parameter. In addition, the Hybrid group and ASR parameter have not found relationships in any case. While all of this, the findings could offer valuable insights into the physiological characteristics underpinning performance in elite soccer.

To establish the differences in locomotor profiles, the results indicate that players categorized with a speed profile demonstrated the highest values in MSS and CMJ. These findings are consistent with prior research suggesting that Speed-oriented players possess enhanced anaerobic capabilities (Silva et al., 2022a; Silva et al., 2022b), reflecting superior neuromuscular power and fast-twitch fiber recruitment

(Buchheit & Méndez-Villanueva, 2014). These players also exhibited the highest Anaerobic Speed Reserve (ASR), indicating a broader gap between their MSS and Maximum Aerobic Speed (MAS), a typical trait of power-dominant athletes (Smith et al., 2025). On the other hand, Endurance profile players had superior MAS and VO_2max, reflecting a physiological emphasis on aerobic efficiency, performance and fatigue resistance (Silva et al., 2022a; 2022b), which is in line with training adaptations favoring mitochondrial density, capillarization, and slow-twitch fiber predominance (Jones & Carter, 2000).

Interestingly, a strong negative association was observed between CMJ and MAS within the Endurance group (Spearman's rho = -0.804, strong; *p* = 0.029; ES = 0.473, small), suggesting that greater explosive power may not only be unhelpful but potentially detrimental to aerobic performance in this subgroup. In this line, CMJ (explosive movement) is positively associated with sprint speed and agility (Oleksy et al., 2024). This inverse relationship obtained may be explained by the physiological trade-off between muscle fiber composition and metabolic efficiency. Athletes with higher CMJ scores likely possess a greater proportion of Type II (fast-twitch) muscle fibers, which, while advantageous for explosive movements, are less efficient for sustained aerobic activity (Swinnen et al., 2024). Consequently, a higher CMJ may reflect a neuromuscular profile less optimized for endurance, possibly due to increased muscle mass or a mismatch in fiber type for aerobic demands. While CMJ is positively associated with sprint speed and agility—key attributes in soccer performance (Oleksy et al., 2024)—its relevance to endurance appears limited. The stretch-shortening cycle and neuromuscular explosiveness captured by CMJ are crucial for high-intensity efforts, particularly during the final stages of intermittent endurance tests (Silva et al., 2022b), but may not align with the physiological demands of sustained aerobic output.

In reference to the VO_2max and their influence on the parameters of high intensity running tolerance, in players with a speed locomotor profile, very strong correlations were observed between VO_2max and both MAS (Spearman´s rho = 0.872; p = 0.054; ES = 0.610) and MSS (Spearman´s rho = 0.900; p = 0.083; ES = 0.613), accompanied by moderate-to-large effect sizes, despite p-values slightly exceeding conventional significance thresholds. These findings underscore a potential physiological interaction wherein higher aerobic capacity may enhance high-intensity performance and recovery in speed-dominant players. Specifically, elevated VO_2max may act as a performance buffer, supporting quicker metabolic recovery and enabling the repetition of high-speed efforts with reduced fatigue (Dupont et al., 2004). Furthermore, VO_2max contributes to a higher MAS, allowing athletes to perform sustained submaximal activities closer to their maximal sprint speeds. This is particularly relevant in match-play scenarios, where repeated sprints and transitions demand both anaerobic explosiveness and efficient aerobic recovery (Slimani et al., 2019). Prior studies emphasize that improving VO_2max enhances activity during high-intensity efforts, shortens recovery times between actions, and supports performance in explosive intermittent movements (Silva et al., 2011; Quagliarella et al., 2011; Ziogas et al., 2011). Consequently, incorporating VO_2max assessments—such as the 30–15 Intermittent Fitness Test (30–15 IFT)—into regular training can not only monitor aerobic capacity but also guide the prescription of individualized training intensities (Buchheit, 2008; Silva et al., 2022a), especially for speed-oriented athletes whose performance depends on both energy system integration and recovery dynamics.

These insights highlight the traditional dichotomy between aerobic and anaerobic specialization and supports a more integrated view, particularly in team sports where intermittent high-intensity demands require both capacities (Bradley et al., 2010). The intermittent nature of soccer, characterized by alternating periods of low-to-moderate exertion and maximal efforts, necessitates that players possess well-developed aerobic and anaerobic power to maintain the required intensity throughout the match (Baker et al., 2025). The interplay between VO_2max and MSS in speed-dominant players may also reflect more individualized training adaptations, where conditioning regimes enhance both endurance and sprint mechanics simultaneously. For this, training methodologies that enhance both aerobic and anaerobic capacities can significantly improve overall physical fitness and match performance (Oliva-Lozano et al., 2020). Considering that VIFT is justified by different measures including aerobic fitness, change-of-direction or lower limb power. Moreover, considering that anaerobic systems is it is also expectable to assist to an improvement of ASR as well (Selmi et al., 2020).

However, this study is not without limitations. The key limitation of this study is the relatively small sample size and potential lack of player positional specificity within each locomotor profile, which could affect generalizability. Moreover, the correlational nature of the study precludes causal interpretations.

Furthermore, the cross-sectional design captures data at a single point in time, which may not adequately reflect the dynamic nature of locomotor profiles and physical performance over time. Future research should explore longitudinal interventions to assess how targeted training modifies the interactions among CMJ, MAS, MSS, ASR, and VO_2max within specific locomotor profiles. Integration with physiological markers such as lactate threshold, muscle fiber typing, or oxygen uptake kinetics may also provide more objective insight.

Conclusions

This study highlights the distinct physiological profiles of professional soccer players based on their locomotor characteristics and demonstrates how these profiles relate to key performance indicators such as jumping ability and aerobic capacity. Speed-dominant players exhibited superior neuromuscular power, reflected in higher CMJ and MSS values, whereas endurance-oriented players achieved greater VO_2max and MAS, reflecting enhanced aerobic capacity. Notably, CMJ performance was inversely associated with MAS in endurance players, suggesting a possible trade-off between explosive strength and aerobic efficiency. Conversely, in speed players, VO_2max showed strong associations with both MAS and MSS, indicating a potential integrative role of aerobic fitness in supporting repeated high-intensity efforts.

These findings provide information about the different soccer player profiles and suggest the value of individualized training and profiling in elite soccer, where different positional roles and locomotor demands require tailored physical preparation. Coaches and practitioners should consider the specific interactions between power and endurance capabilities to optimize performance development across the diverse profiles present within a professional team.

Acknowledgements

We would like to give our sincere gratitude to the football club KMSK Deinze (Belgium) for their selfless collaboration in the realization of this study. Special thanks to the technical staff and the players of the team.

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