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Article

Physical Development Differences between Professional Soccer Players from Different Competitive Levels

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Abstract: In soccer, physical development is crucial for developing optimal performance. This study aimed to assess and compare the physical development of elite and non-elite professional soccer players. Seventy-eight male professional football players divided into four competitive levels participated in this study: the elite group (EG), the non-elite group A (NEG-A), the non-elite group B (NEG-B), and the under 23 group (U23). Body composition, static strength, lower-body explosive strength, flexibility, and balance were assessed. No significant statistical differences between elite and non-elite players were seen in body composition parameters. However, the EG performed better in static strength, lower-body explosive strength, flexibility, and balance, even after adjusting for the effects of chronological age. The analysis showed that the competitive level (group) explained 25% to 29% of the variance observed in the lower-body explosive strength tasks. Sports staff and coaches in different age categories or competitive levels should include specific lower-body explosive strength content during soccer training to promote players' long-term development towards the elite level.

Keywords: strength; balance; flexibility; body composition; elite



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1. Introduction

Physical development is essential to optimal performance among soccer players [1,2]. Indeed, previous research aimed at identifying the differences between elite and non-elite professional soccer players has pointed out variables related to the players' physical attributes as the main discriminant factors among competition levels [2,3].

The adverse effects of body fat percentage (BF%) on game performance have been consistently described in the soccer literature, particularly regarding sprinting, change of direction, and jumping task performance [4,5]. BF% was described as one crucial discriminator between players' competitive level among youth soccer players, since elite groups consistently presented a lower BF% than non-elite groups [2]. On the other hand, the body composition analysis of male professional soccer players competing in the English Premier League concluded that there is a slight variation between individuals [6]. In the professional context, little information is available on the body composition of players competing at different levels. The detrimental effect of BF% on speed and agility capacities,

which are pointed out as the most predominant actions preceding goals and other decisive situations [7], justifies the need to seek more details on this topic.

Meanwhile, strength has been consistently evaluated worldwide in sports, which is a significant predictor of performance. Among testing protocols, handgrip emerges as an attribute of elite athletes and a covariate of overall strength [8]. On the other hand, lower-body explosive strength, which is frequently assessed through vertical jumping, has been described as a crucial influencer of sprinting and change of direction tasks [9,10]. In a study conducted among professional soccer teams from different competitive levels, the authors reported a significant relationship between the teams' success and both the countermovement jump (CMJ) and the squat jump (SJ) performance [11]. Consistently, the sports literature has suggested that optimizing strength, particularly in the lower body, helps enhance speed and agility [12–14].

On the other hand, postural balance is one of the less-studied variables of players' physical development. However, balance is an influencer of performance, particularly in sport-specific skills and injury prevention [15]. Balance is maintained through a complex process involving sensory detection of body motions. Individuals must integrate sensorimotor information and execute an appropriate musculoskeletal response [16]. Postural instability may occur due to increased fatigue, influencing the systems integrating postural control [17,18]. Previous research has shown that muscular weakness was associated with worse performance in proprioceptive postural control [19]. Moreover, training individuals have a more developed sense of balance than non-training individuals, and the level of playing experience influences postural control performance measures and strategies [20].

Most of the studies developed among professional soccer players aimed to evaluate differences in their profiles according to their positional roles [6,21,22]. There are only limited data concerning the physical characteristics of professional soccer players competing at different levels. However, this information is highly relevant, especially for those who work with non-elite soccer players. Therefore, to close these critical gaps, this study aimed to assess and compare, in detail, the body composition, strength, and balance parameters of elite and non-elite professional soccer players. It was hypothesized that elite players will present superior performance in all variables assessed compared to their non-elite peers.

2. Materials and Methods

2.1. Participants

Seventy-eight male professional football players divided into four competitive levels participated in this study: the elite group (EG) was competing in the first Portuguese professional league; the non-elite group A (NEG-A) was competing in the fourth Portuguese national league; the non-elite group B (NEG-B) was competing at the first regional level; and the under 23 group (U23) was competing in the first Portuguese national league for their age group. Twenty-two players were in the EG (age = 26.1 ± 4.2 years, height = 181.3 ± 6.3 cm, body mass = 78.0 ± 7.1 kg); seventeen players were in the NEG-A (age = 22.3 ± 1.8 years, height = 180.9 ± 9.5 cm, body mass = 78.5 ± 11.6 kg); eighteen players were in the NEG-B (age = 28.1 ± 6.1 years, height = 178.0 ± 6.6 cm, body mass = 76.0 ± 8.1 kg); and twenty-one players were in the U23 group (age = 20.7 ± 1.5 years, height = 178.5 ± 6.1 cm, body mass = 73.2 ± 8.8 kg). Body composition and balance were first assessed in a laboratory, followed by static strength, lower-body explosive strength, and flexibility, which were performed in a physical performance laboratory. All test assessments were conducted by trained staff from the research team, familiar with each protocol. The procedures applied were approved by the Ethics Committee of the Faculty of Human Kinetics, CEIFMH N° 34/2021. The investigation was conducted following the Declaration of Helsinki, and informed consent was obtained from all participants.

2.2. Body Composition

Stature was measured to the nearest 0.01 cm using a stadiometer (SECA 213, Hamburg, Germany). Body composition variables were assessed using hand-to-foot bioelectrical

impedance analysis (InBody 770, Cerritos, CA, USA). The assessment occurred in the early morning for four consecutive days in a laboratory. Each day corresponded to the evaluation of one group. The mean time between the first and the last evaluation was about 12 min. All measurements occurred with the participants fasting and wearing only their underwear. On the platform, participants were barefoot, standing with their arms 45° from their trunks, and with their feet on the defined spots. Body mass, body fat percentage (BF%), fat-free mass (FFM), and total body water (TBW) were retained for analysis.

2.3. Handgrip

The handgrip protocol consisted of three alternated data collection trials for each arm using a hand dynamometer (Jamar Plus+, Chicago, IL, USA). The assessment occurred in a physical performance laboratory, and the rest interval between trials was 60 s. Participants were standing and were instructed to hold a dynamometer in one hand, laterally to the trunk with the elbow at a 90° position [23]. In this position, participants were asked to squeeze as hard as possible for about two seconds. If the dynamometer contacted the participant's body, the trial was repeated. The best score of the three trials was retained for analysis.

2.4. Lower-Body Explosive Strength

The countermovement jump (CMJ) and the squat jump (SJ) were used to assess lower-body explosive strength [24]. Both protocols included four data collection trials 30 s apart and were performed using the Optojump Next (Microgate, Bolzano, Italy) system of analysis and measurement. Participants were encouraged to jump to a maximum height during each assessment. Before data collection, three experimental trials were performed by each participant to ensure correct execution. In total, each participant performed seven trials in each jumping assessment. All evaluations were conducted in a physical performance laboratory.

For the CMJ, participants began standing, with their feet placed hip-width to shoulder-width apart. Then, participants executed a countermovement to a depth position near 90° of knee flexion, followed by a maximal-effort vertical jump. Their hands remained on the hips for the entire movement to avoid the influence of arm swing. The trial was repeated if the hands were removed from the hips, or if excessive knee flexion was exhibited during the countermovement. The participants reset to the starting position after each jump. The best score was retained for analysis.

The SJ protocol began with the participant squatting at nearly 90° of knee flexion depth. The participants held this position before jumping to a maximum height. If a dipping movement of the hips was evident, then the trial was repeated. After each jump, the starting position was reset. The best score was retained for analysis.

2.5. Flexibility

Sit and reach tests were used to evaluate flexibility measurements. A sit and reach trunk flexibility box (32.4 cm high and 53.3 cm long) with a 23 cm heel line mark was used. The assessments occurred in a physical performance laboratory. Participants sat barefoot in front of the box for the unilateral evaluation, with the knee fully extended and the heel placed against the box. The research team held one hand lightly against the participant's knee to ensure complete leg extension. Then, participants placed their hands on top of each other, palms down, and slowly bent forward along the measuring scale. The forward hold position was repeated twice. The third and final forward stretch was held for three seconds, and the score was recorded to the nearest 0.1 cm. The first procedure was performed with the right leg and then the left. The same procedure was used for the bilateral assessment, placing both heels against the box. Participants performed two trials for each test, and the best score was used for analysis.

2.6. Balance

Balance was evaluated using the Biodex Balance System SD (Biodex, Shirley, NY, USA). The protocol was performed in a unilateral stance in a laboratory. It consisted of four levels of platform stability for a total of 30 s: level 4 was the most stable, and level 1 was the most unstable (consisting of 3.75 s at each level). The platform provides an assessment of postural stability using three indices: the overall stability index (OSI), the anteroposterior stability index (APSI), and the lateromedial stability index (LMSI). These indices are calculated according to the degree of oscillation of the platform, and lower values indicate that the individual has good stability [25]. Before the assessment, the equipment position was adjusted to the players' height. After, a single training test was conducted to allow players to understand the protocol and minimize learning effects. Each participant performed four testing trials with a rest interval of 60 s between attempts. The testing order was alternated between the dominant and non-dominant sides.

2.7. Statistics

Descriptive statistics were presented as means \pm standard deviations. All data were checked for normality using the Shapiro–Wilk test. A one-way between-group analysis of variance (ANOVA) and post hoc comparisons using the Tukey HSD test were conducted to explore differences in chronological age (CA) and physical development components between groups. A one-way between-group analysis of covariance (ANCOVA) was conducted to compare the differences in strength, flexibility, and balance while controlling for CA. Preliminary checks were conducted to ensure there was no violation of the assumptions of normality, linearity, or homogeneity of variances, and to ensure a reliable measurement of the covariate. All analyses were performed using IBM SPSS Statistics software 26.0 (SPSS Inc., Chicago, IL, USA). The significance level was set at $p \leq 0.05$.

3. Results

Table 1 displays descriptive statistics for CA, body composition, strength, flexibility, and balance tests and the results of the one-way between-group ANOVA. Significant statistical differences were observed for CA ($p \leq 0.01$). The EG was significantly older than the NEG-A and U23 group. In contrast, the NEG-B was considerably older than the NEG-A and U23 group. No significant statistical differences were observed between groups regarding body composition variables.

Regarding the strength indicators, significant statistical differences were found for handgrip ($F = 5.235$, $p \leq 0.01$), CMJ ($F = 10.320$, $p \leq 0.01$), and SJ ($F = 7.987$, $p \leq 0.01$). The EG showed significantly better scores among all groups, followed by the NEG-A. In contrast, the NEG-B presented the lowest scores in the strength tests. Statistically significant differences were also found for the unilateral (right side: $F = 4.324$, $p \leq 0.01$; left side: $F = 4.324$, $p \leq 0.01$) and bilateral ($F = 4.059$, $p \leq 0.01$) sit and reach tests, with EG players showing greater flexibility capacity comparing with their peers. Concerning balance, the EG showed a significantly better performance than the other groups in the OSI ($F = 6.091$, $p \leq 0.01$), APSI ($F = 5.252$, $p \leq 0.01$), and LMSI ($F = 3.256$, $p \leq 0.05$). Lower values of the balance platform oscillation indicated greater balance.

The results of ANCOVA are shown in Table 2. After adjusting for CA, significant statistical differences were found for handgrip ($F = 4.954$, $p \leq 0.01$, partial eta squared = 0.17), CMJ height ($F = 9.977$, $p \leq 0.01$, partial eta squared = 0.29), and SJ height ($F = 7.777$, $p \leq 0.01$, partial eta squared = 0.25), favoring the EG. Elite players also presented significantly better scores both for flexibility and balance.

Table 1. Descriptive statistics for chronological age, body composition, strength, flexibility, and balance tests, and results of the one-way between-group ANOVA.

Variables	Mean ± Standard Deviation				F	p	ANOVA
	EG (n = 22)	NEG-A (n = 17)	NEG-B (n = 18)	U23 (n = 21)			Post Hoc Comparisons
CA (years)	26.1 ± 4.2	22.3 ± 1.8	28.1 ± 6.1	20.7 ± 1.5	14.031	≤0.01 **	EG > NEG-A and U23; NEG-B > NEG-A and U23
Stature (cm)	181.3 ± 6.3	180.9 ± 9.5	178.0 ± 6.6	178.5 ± 6.1	1.405	0.33	
Body mass (kg)	78.0 ± 7.1	78.5 ± 11.6	76.0 ± 8.1	73.2 ± 8.8	1.434	0.24	
Body fat (%)	12.6 ± 3.3	12.8 ± 3.4	13.2 ± 2.5	13.0 ± 2.5	0.232	0.87	
Fat-free mass (kg)	68.2 ± 6.5	68.3 ± 9.1	65.9 ± 7.0	63.6 ± 6.7	1.947	0.13	
TBW (L)	49.8 ± 4.8	49.8 ± 6.5	48.2 ± 5.0	46.4 ± 4.9	1.942	0.13	
Handgrip (kg)	49.0 ± 4.6	48.1 ± 7.6	40.4 ± 8.7	44.7 ± 8.2	5.235	≤0.01 **	EG > NEG-A and NEG-B
CMJ height (cm)	40.1 ± 4.0	38.2 ± 3.5	33.9 ± 3.4	36.9 ± 4.3	10.320	≤0.01 **	EG > NEG-B and U23; NEG-A > NEG-B
SJ height (cm)	38.0 ± 4.3	37.3 ± 3.8	32.5 ± 3.8	35.0 ± 4.2	7.987	≤0.01 **	EG > NEG-B and U23; NEG-A > NEG-B
Sit and reach right (cm)	38.7 ± 6.6	32.9 ± 7.3	32.8 ± 5.7	36.8 ± 5.3	4.324	≤0.01 **	EG > NEG-A and NEG-B
Sit and reach left (cm)	38.1 ± 6.0	32.1 ± 6.7	33.3 ± 6.8	36.2 ± 5.6	3.732	0.02 *	EG > NEG-A
Sit and reach bilateral (cm)	39.9 ± 7.9	32.8 ± 9.0	32.6 ± 8.1	36.7 ± 5.7	4.059	≤0.01 **	EG > NEG-A and NEG-B
OSI (°)	3.40 ± 1.82	4.02 ± 1.33	5.51 ± 2.89	6.05 ± 2.53	6.091	≤0.01 **	EG < NEG-B and U23; NEG-A < U23
APSI (°)	1.36 ± 0.69	1.69 ± 0.75	2.53 ± 2.53	3.52 ± 2.58	5.252	≤0.01 **	EG < U23; NEG-A < U23
LMSI (°)	2.84 ± 1.81	3.36 ± 1.38	4.40 ± 2.32	4.36 ± 1.92	3.256	0.03 *	EG < NEG-B and U23

EG, elite group; NEG-A, non-elite group A; NEG-B, non-elite group B; U23, under 23 group; CA, chronological age; TBW, total body water; CMJ, countermovement jump; SJ, squat jump; OSI, overall stability index; APSI, anteroposterior stability index; LMSI, lateromedial stability index; * $p \leq 0.05$; ** $p \leq 0.01$.

Table 2. Results of the one-way between-group analysis of covariance for physical development tests after adjusting for CA.

Variable	Estimated Marginal Means (95% CI)				F	p	Partial Eta Squared
	EG	NEG-A	NEG-B	U23			
Handgrip (kg)	49.0 (45.6 to 52.3)	48.1 (33.3 to 51.9)	40.4 (36.5 to 44.3)	44.7 (41.0 to 48.4)	4.954	≤0.01 **	0.17
CMJ height (cm)	40.7 (39.0 to 42.4)	38.2 (36.2 to 40.2)	33.9 (31.8 to 35.9)	36.9 (34.9 to 38.8)	9.977	≤0.01 **	0.29
SJ height (cm)	38.4 (36.6 to 40.1)	37.4 (35.3 to 39.4)	32.4 (30.2 to 34.5)	35.1 (33.1 to 37.1)	7.777	≤0.01 **	0.25
Sit and reach right (cm)	38.7 (36.0 to 41.5)	33.0 (29.8 to 36.1)	32.7 (29.4 to 36.0)	36.9 (33.7 to 40.0)	4.252	≤0.01 **	0.15
Sit and reach left (cm)	38.3 (35.5 to 41.0)	31.9 (28.8 to 35.1)	33.6 (30.3 to 36.9)	35.9 (32.8 to 39.0)	3.719	0.02 *	0.13
Sit and reach bilateral (cm)	40.0 (36.7 to 43.4)	32.7 (28.8 to 36.5)	36.4 (28.8 to 36.9)	32.9 (32.6 to 40.2)	3.999	≤0.01 **	0.14
OSI (°)	3.51 (2.53 to 4.49)	3.88 (2.69 to 5.07)	5.77 (4.60 to 6.94)	5.81 (4.70 to 6.91)	5.694	≤0.01 **	0.20
APSI (°)	1.52 (0.71 to 2.32)	1.48 (0.50 to 2.46)	2.92 (1.95 to 3.89)	3.16 (2.24 to 4.08)	4.380	≤0.01 **	0.16
LMSI (°)	2.85 (2.01 to 3.68)	3.35 (2.34 to 4.37)	4.41 (3.41 to 5.41)	4.35 (3.40 to 5.30)	3.191	0.03 *	0.12

95% CI, 95% confidence interval; EG, elite group; NEG-A, non-elite group A; NEG-B, non-elite group B; U23, under 23 group; CMJ, countermovement jump; SJ, squat jump; OSI, overall stability index; APSI, anteroposterior stability index; LMSI, lateromedial stability index; * $p \leq 0.05$; ** $p \leq 0.01$.

4. Discussion

This study aimed to assess and compare the physical development components of professional soccer players competing at different levels. No significant statistical differences between elite and non-elite players were seen in body composition parameters. However, elite players performed significantly better in static strength (handgrip), lower-body explosive strength (CMJ and SJ), flexibility (sit and reach), and balance tests, even after adjusting for the effects of CA.

In a study comparing anthropometric and body composition variables between players from the Serbian premier league and the fifth Serbian league, the authors found that elite players were significantly heavier and had a lower BF% than non-elite players [26]. However, in line with our findings, another study conducted on 132 male professional soccer players found that there were no significant differences in height, body mass, and BF% between players from Division 1 and Division 2 [27], even though players from Division 1 were taller, heavier, and presented a lower BF% than players from Division 2. It is essential to clarify that BF% has been negatively correlated with physical development test performance in previous research [2,28,29], especially for tests which require full-body movement such as vertical jumping, sprinting, and change of direction. In this study, although body composition parameters were not different between elite and non-elite players, it is essential to underline the importance of monitoring body composition during the season to achieve better physical development levels.

In our results, elite players showed substantially better scores in static strength than non-elite players. The mean score of the EG was almost 18% higher (approximately 9 cm) than that of the NEG with the lowest score (NEG-B). A previous study which aimed to compare the handgrip performance of a group of amateur soccer players and a group of healthy adults concluded that soccer players attained larger mean values in handgrip than the control group (+5.6 kg, $p \leq 0.01$) [30]. Indeed, these results would be expected due to the systematic training that amateur soccer players are submitted to. Across several sports contexts, elite players have shown significantly better scores on the handgrip performance than their non-elite peers [8], which is in line with our findings. Handgrip is an isometric strength measure described as a strong predictor of absolute strength [31,32] that coaches may consider in the training process of non-elite players.

Meanwhile, the mean score of the EG was approximately 17% better for the CMJ performance (nearly 7 cm) and 16% better for the SJ performance (almost 6 cm) than that of the NEG with the lowest score (NEG-B), even after adjusting for the effects of CA. These results would be expected since lower-body explosive strength has been consistently related to game performance, particularly to high-intensity actions such as sprinting and changing direction, which have been described as the most decisive actions preceding goals [7,9]. Thus, since speed and agility capacities are crucial for elite soccer players, higher levels of lower-body explosive strength were expected to be observed in this population. According to the literature, lower-body strength strongly predicts speed and agility [28,33]. Past research among 25 male professional soccer players aged 25.1 ± 4.6 years reported that increased lower-body strength was strongly correlated with faster 30 m linear sprint times ($r = -0.57$, $p \leq 0.01$) and a greater CMJ height ($r = 0.39$, $p \leq 0.05$) [33]. In another sample of junior male soccer players aged 17.0 ± 0.5 years, the SJ was described as a strong predictor of acceleration and 5 m linear sprint time [34]. In summary, the results of this study, combined with past findings, may raise awareness regarding strength development as part of the soccer training process and as a crucial tool to enhance game performance. Again, this information is highly important for coaches who manage the training process of non-elite soccer players. They should consider the development of lower-body explosive strength to approximate the physical profile of the non-elite player to the elite one.

According to our analyses, elite players presented a substantially better performance in the flexibility and balance tests. Muscle flexibility is a main component of physical development since deficits in some range of motion might restrict specific skills performance and increase injury risk [35]. On the other hand, balance is also related to sport-specific

skills performance and injury risk [15]. Our results show that elite players presented lower oscillation on the balance platform during testing procedures, which means better stability. In soccer, the literature available on the balance topic is scarce. However, a study comparing the postural control between professional and junior elite soccer players concluded that professional players had better balance than players in the other groups [15], which partially supports our results. Those results could be associated with professional players' long-term practice and improved knowledge of body posture compared to junior players.

In this study, significant differences were found for CA between groups, which could confound the physical development assessment. However, after adjusting for CA scores in the ANCOVA, the differences among physical development components remained, favoring the EG. The main effect size was observed for lower-body explosive strength tasks. The competitive level (group) explained 29% of the variance observed in the CMJ height, and 25% of the variance observed in the SJ height. Our results indicate that lower-body explosive strength is the main discriminator between competitive levels, reinforcing the need to include specific strength contents in the professional soccer training process.

Overall, this study presents some limitations, such as the use of cross-sectional data, and the lack of control of the maturity status and training methods used by each group. Additionally, the absence of data regarding speed, agility, and aerobic and anaerobic endurance should be underlined. Future works including these assessments may be more informative, particularly by exploring the relationship between strength and speed. The research conducted in the professional soccer context is scarce and has been mainly focused on the individuals' profiles without considering their competitive level [4,6,22,33]. Importantly, our results call for awareness among sports staff and coaches to monitor body composition and promote strength development throughout the season. It is crucial to avoid the detrimental effects of BF% on sports performance. On the other hand, lower-body explosive strength was the main discriminator between competitive levels, even after controlling for CA. Therefore, coaches in different age categories or competitive levels are highly encouraged to promote lower-body explosive strength during soccer training as part of the players' long-term development towards the elite level.

5. Conclusions

Even after controlling for the effects of CA, elite professional soccer players presented an overall better performance in strength, flexibility, and balance tests than their non-elite peers. On the other hand, body composition variables did not differ substantially between groups. Lower-body explosive strength was the main discriminator between players competing at several competitive levels, with elite players performing significantly better than their non-elite peers. Our results show that the competitive level could explain between 25% and 29% of the variance observed in the SJ and CMJ, respectively. Thus, lower-body explosive strength contents should be included in designing soccer training sessions in different age groups and competitive levels to promote players' development towards the elite level.

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