Body composition, strength and muscle power indices at the different competitive levels of Futsal

Índices de composición corporal, fuerza y potencia muscular en los diferentes niveles competitivos del fútbol sala

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Abstract

Objective: The aim was to verify the differences in physical condition (body composition, power and muscle strength) in futsal players from three competitive levels.
Methodology: Sixty-eight (24.26 ± 4.63 years old) Portuguese futsal players participated in the study, divided into: elite, sub-elite and amateur. We used the bioimpedance, the countermovement jump and the isokinetic dynamometer to assess physical condition, and the Kruskal-Wallis test to compare variables between groups.
Results: There were no differences in body composition between groups. Elite players had higher countermovement jump heights than amateur players ($p < 0.001$). There were significant differences in the isokinetic muscle strength of the knee flexors, with the elite players showing more strength than the amateur players ($p = 0.047$).
Discussion: The results of the research should be contrasted with those of other research found in the literature.
Conclusions: The elite players had higher physical condition parameters (more lower limb power and more flexor muscle strength) compared to the amateur players. We would point out that all groups had a high probability of lower limb muscle injury (H/Q ratio < 60%) at this stage of the sports season, alerting training professionals to the importance of individualised physical condition analysis.

Keywords

Body composition; futsal; muscle power; muscle strength; physical condition.

Resumen

Objetivo: El objetivo fue verificar las diferencias en la condición física (composición corporal, potencia y fuerza muscular) en jugadores de fútbol sala de tres niveles competitivos
Metodología: Sesenta y ocho (24,26 ± 4,63 años) jugadores portugueses de fútbol sala participaron en el estudio, divididos en: élite, sub-élite y amateur. Se utilizó la bioimpedancia, el salto en contramovimiento y el dinamómetro isocinético para evaluar la condición física, y el test de Kruskal-Wallis para comparar variables entre grupos.
Resultados: No hubo diferencias en la composición corporal entre los grupos. Los jugadores de élite tenían mayor altura de salto en contramovimiento que los jugadores aficionados ($p <$ 0,001). Hubo diferencias significativas en la fuerza muscular isocinética de los flexores de la rodilla, mostrando los jugadores de élite más fuerza que los jugadores aficionados ($p =$ 0,047).
Discusión: se deben contrastar los resultados de la investigación con los de otras investigaciones encontradas en la literatura.
Conclusiones: Los jugadores de élite presentaban parámetros de condición física más elevados (más potencia en los miembros inferiores y más fuerza muscular en los flexores) en comparación con los jugadores aficionados. Cabe destacar que todos los grupos presentaban una alta probabilidad de lesión muscular de miembros inferiores (relación H/Q < 60%) en esta fase de la temporada deportiva, lo que alerta a los profesionales del entrenamiento sobre la importancia del análisis individualizado de la condición física.

Palabras clave

Composición corporal; condición física; fuerza muscular; fútbol sala; potencia muscular.

Introduction

Futsal is a high intensity team sport whose players must constantly perform offensive and defensive tasks at a substantially high intermittent rate (Barbero-Alvarez et al., 2008). In general, futsal players cover an average of 4km per game and perform low-intensity efforts every 14 seconds, medium-intensity efforts every 37 seconds, high-intensity efforts every 43 seconds and, finally, maximum-intensity efforts every 56 seconds (Naser et al., 2017; Spyrou et al., 2020). Since this sport values the physical condition of its players to respond to the demands imposed by the game and the opponent (Gorostiaga et al., 2009), it is essential to know the initial physical condition of futsal players of different competitive levels in terms of body composition, power and muscle strength, since these capacities are fundamental in the execution of specific futsal tasks (e.g. shooting, dribbling, passing, ball recovery) and in players' movements on the pitch (e.g. acceleration, deceleration, sprints, changes of direction (Castagna et al., 2009; Ribeiro et al., 2020).

According to the evidence in the literature, as it is a sport with a high level of physical intensity, sports professionals need to have detailed knowledge of the demands of the sport and its relationship with the players' physical condition in order to prescribe training better (Castagna et al., 2009). However, although it is a growing sport, some authors point out that there is still little research into the physical condition, particularly the muscle strength, muscle power and anthropometric characteristics of players in this sport, and at different competitive levels (Castagna et al., 2009; Ayarra et al., 2018). In particular, Ayarra et al. (2018) high-light the need to develop studies to analyse whether there are differences in the physical condition of futsal players depending on the level of competition. These comparative analyses are important because they reveal physiological and anthropometric factors that differentiate players at different competitive and specialisation levels (Naser & Ali, 2016).

Given the very pronounced evolution that futsal has undergone in the last decade, its players should be encouraged to work very close to their limits, especially given the increasing physical, tactical, technical and psychological demands (Kurata et al., 2007). For this reason, it would be essential for the development of futsal to understand the physical requirements of this sport in detail. It is known that identifying the key aspects of physical condition is important because it can affect various aspects of the game, including training methods (Dogramaci et al., 2011).

Body composition is an essential variable since its parameters can positively or negatively influence sports performance, thus representing a highly informative predictor for training methodology (Mazić et al., 2014; Figueiredo et al., 2021), however, the anthropometric characteristics of futsal players have not been sufficiently investigated. Therefore, in futsal teams, it is essential to monitor anthropometric variables and physical abilities in order to individualize players and identify potential improvements to include in the training routine (Castillo González et al., 2023).

Although excess body fat represents an inert load that can impair physical and sport performance, predisposing the player to a greater risk of injury (Nikolaidis, 2012), the assessment of body composition should include other equally important parameters, such as fat-free mass and body water, which influence the sport performance and health of players. Muscle mass has a direct impact on strength, endurance and recovery capacity, fundamental aspects in high-intensity futsal (Silva, 2019). The study by Nikolaidis et al. (2019) warns of the prevalence of overweight in futsal players, highlighting the need to consider all body composition components for a more complete and efficient assessment. Electrical bioimpedance is a widely used method in the sports context due to its ease of use, low cost and portability (Driskell & Wolinsky, 2011), making it a valid and effective tool for this assessment. In addition to providing data on muscle mass and body fat, electrical bioimpedance also makes it possible to analyze the estimated fat free mass and body water distribution, providing a more complete analysis of the athlete's physical state (Campa et al., 2021; Campa et al., 2022; Matias et al., 2023). This integrated approach is particularly valuable for monitoring the periodization of the training process and evaluating sports performance, as advocated by Ackland et al. (2012) and Thomas et al. (2016). In addition, measuring body water can be relevant for assessing a player's water balance, another factor that impacts performance, especially during intense competitions (Coratella et al., 2021). Thus, understanding these components makes it possible to design personalized training and nutritional strategies that improve athletic abilities and mitigate the risk of injury.

On the other hand, in terms of physical fitness, strength and power are fundamental skills for better performance in futsal players. Strength is related to the muscle's ability to resist a given resistance and power is associated with the neuromuscular system's ability to generate maximum force in the shortest possible time (Hoff & Helgerud, 2004; Young, 2006). Lean muscle mass plays a fundamental role in optimizing strength and power, and is another essential component of a player's physical condition (Milsom et al., 2015). Although the assessment of muscle strength using an isokinetic dynamometer does not completely reproduce the functional pattern required in futsal, it is important in analysing the performance of futsal players and is essential for the objective assessment of muscle capacity at the start of the sports season, being able to identify strength imbalances (Nunes et al., 2018), and consequently determine the risk of muscle and joint injuries (Wilkosz et al., 2021).

Lower limb power is commonly assessed indirectly through the Countermovement Jump (CMJ) as it is considered a jump that represents the muscle cycle of stretching and shortening, which can be summarized as the effectiveness of the neuromuscular system in producing maximum force in the shortest possible time (Wang & Zhang, 2016), this being a fundamental aspect in sports that require repeated sprinting (Slimani & Nikolaidis, 2019; Figueiredo et al., 2021), as in the case of futsal. In previous studies, futsal players have achieved CMJ values between 35 and 52 cm (Naser & Ali, 2016; Ruiz-Pérez et al., 2023). Therefore, assessing the physical condition of futsal players and verifying the differences between competitive levels is pertinent, making it a regular practice in order to improve the planning and prescription of training and subsequently obtain better results (Sutton et al., 2009).

Other studies comparing competitive levels indicate that sub-elite or amateur players need a substantially higher volume and intensity of training to achieve the same physical condition and body composition as elite athletes (Slimani et al., 2018; Slimani & Nikolaidis, 2019). Naturally, depending on the competitive level, there is greater or lesser intensity in the training, load, competitions and tournaments in which the divisions participate (Castillo González et al., 2023). It should be noted that the number of studies related to futsal has increased in recent years. However, the justification for this study comes from the lack of knowledge about the differences in initial physical condition, in terms of body composition, power and isokinetic muscle strength, between the various competitive levels of futsal, so the aim of this study was to verify the differences in physical condition between the various competitive levels of futsal. According to the existing literature, we expect to find better results in body composition, lower limb strength and power at the elite level of futsal compared to the sub-elite and amateur groups (Ayarra et al., 2018; Slimani et al., 2018; Slimani & Nikolaidis, 2019; Belo et al., 2024).

With this study, we hope to highlight the importance of assessing physical condition at the start of the preseason, which is a valuable step towards sports success, as it allows training and fitness professionals to identify the individual needs of futsal players and health professionals to identify modifiable risk factors that potentially reduce the risk of injury (Ferreira et al., 2017; Figueiredo et al., 2021).

Method

Study Design

This research is part of a quantitative approach, considered a cross sectional study. With regard to the nature of the sample, we can say that it was selected intentionally and conveniently, as it suited the type of study in question and we classified it as non-probabilistic, as it was based on the researcher's subjective criteria and in accordance with the study's specific objectives (Tuckman, 2000).

Participants

This study involved 68 futsal players (24.26 ± 4.63 years old) divided into three groups: elite (N = 13; 23.77 ± 4.38 years old), sub-elite (N = 39; 25.36 ± 4.83 years old) and amateur (N = 16; 22 ± 3.55 years old). The elite players compete in Portugal's first league, the sub-elite players compete in Portugal's second and third leagues and the amateur players compete in the district league. The groups' anthropometric characteristics (age, weight, and height) are presented in Table 1.

Table 1. Characteristics of subjects

Group	N	Age	Weight	Height
Elite	13	23.77 ± 4.38	73.32 ± 6.23	1.75 ± 0.05
Sub-Elite	39	25.36 ± 4.83	72.56 ± 7.99	1.73 ± 0.05
Amateur	16	22.01 ± 3.55	72.96 ± 15.61	1.76 ± 0.07

For the sample selection, the inclusion criteria were all senior male players from the respective teams accordingly registered with the club, and the exclusion criteria were the existence of an injury at the time of the assessment

Instruments

To assess body composition, we used a bioimpedance scale (InBody 270, Biospace, California, USA) with a tetrapolar electrode system with 8 electrodes and frequencies of 20 and 100 kHz, which allowed us to analyse the following variables: total body water, fat free mass, muscle mass, fat mass and percentage body fat (%BF), and a portable stadiometer to identify and enter height on the scale. The CMJ was used to estimate lower limb power using a jumping platform (ChronoJump Boscosystem). An isokinetic dynamometer (System 4, Biodex Medical Systems, Shirley, New York, USA) was used to assess lower limb muscle strength.

Procedures

Primarily, formal and institutional contact was made with the clubs, presenting the objects and asking for their cooperation, after acceptance, the participants filled out a characterization form and an informed consent form. Next, all the players were explained, within the defined inclusion criteria, the evaluation procedures and purposes of the study, which respect and preserve all the ethical principles, norms and international standards that concern the Declaration of Helsinki and the Convention on Human Rights and Biomedicine.

All the evaluations were carried out by three researchers over three days, starting at 9 a.m. and finishing at 3.30 p.m., for approximately 45 minutes per participant, in a specific laboratory, following a particular sequence:

Firstly, body composition was assessed using a bioimpedance scale (InBody 270) (Belo et al., 2024; Tereso et al., 2024), in a room with controlled temperature (22 ± 1.5 °C) and relative humidity of less than 70%, as recommended for standardized bioimpedance measurements (González-Correa & Caicedo-Eraso, 2012). The participants were assessed in a standing position, with their feet properly placed on the electrodes and then, at the device's signal, they held the upper limb electrodes with their hands and kept their arms extended at a 45º angle to their trunk for 60 seconds. Before the test, the palms of the hands and soles of the feet were cleaned with alcohol wipes to optimize electrode contact and reduce potential variability. In addition, to minimize variability, participants were instructed to follow specific guidelines: fasting for at least 4 hours, abstaining from intense physical activity for 24 hours, emptying the bladder and bowels in the 30 minutes before the test, avoiding excessive water intake in the 2 hours before the test (Heyward, 2000). Metal accessories were removed to avoid interference and all measurements were taken after a standardized 10-minute rest in a sitting position to allow the fluids to stabilize. The assessment took approximately 1 minute per participant and the environmental conditions were recorded to ensure consistency.

Secondly, lower limb power was assessed using the CMJ, asking the athletes to keep their hands on their hips to minimise the influence of the upper limbs on jumping and coordination, followed by the instruction to perform a squat up to approximately 90°, involving flexion of the knees and hips, followed immediately by extension of the limbs to jump as high as possible, according to the method proposed by Bosco et al. (1983) by jumping with both feet, without pausing at the base of the squat. Each athlete performed three CMJ from the bipedal position, with a brief recovery interval between repetitions (10 to 20 seconds), until they were ready to perform the next jump, and the maximum height obtained from the best of the three jumps was recorded. The CMJ procedure took approximately 3 to 4 minutes per participant.

Thirdly, the muscle strength of the quadriceps and hamstrings was assessed using concentric isokinetic tests on the dominant and non-dominant limb, following the protocol used in other studies (Kyritsis et al., 2016). Knee dominance was determined by asking the participants which limb they preferred to use when kicking a ball (de Lira et al., 2017). Initially, the players warmed up on a cycle ergometer for 10 minutes at a low speed; then they were positioned correctly on the dynamometer, with the knee and hip at 90°, the knee flexion angle was set at 110° and 0° in extension. The weight of the limb was used to correct for the effects of gravity. Three straps were used to secure the thoracic region, the hip and the knee to prevent undesired movements. Afterwards, the athletes were asked to perform five repetitions of knee extension and flexion at 60°/s, this being the recommended angular velocity to recruit the greatest number of motor units (Baltzopoulos & Brodie, 1989). The athletes were verbally encouraged to perform maximum strength during the tests. We recorded the peak concentric torque of the knee joint's extensors and flexors. The H/Q ratio was calculated by dividing the peak concentric torque of the hamstrings by that of the quadriceps during the same contraction speed. This procedure took a total of 30 minutes per participant.

All the data was collected by the same research team, using a record sheet set up for the purpose. At the end of the data collection, those were made available to the respective technical teams so that they were aware of their players' abilities.

Data analysis

The data was analysed using the Statistical Package for the Social Sciences (SPSS) (v.23.0). All the data collected was gathered and descriptive statistics were used to calculate means, standard deviation, minimums and maximums. The Shapiro-Wilk test is used to verify the normality of the data distribution (p < 0,05). We then used the non-parametric Krushkal-Wallis test to see if there were any differences between the three competitive levels of the sport and a post hoc comparison with Bonferroni correction to compare the results of the groups between pairs. The significance level for these tests was set at 5%. Inferences were also made based on the magnitude of the effects using the following scale (Cohen's d): 0-0.2, trivial; 0.21-0.6, small; 0.61-1.2, moderate; 1.21-2.0, large; ≥2.0, very large.

Results

Table 2 shows the mean values and standard deviation of the body composition (total body water, fat-free mass, muscle mass, fat mass and %BF) of the players assessed according to their competitive level. The Kruskal Wallis test showed no significant difference for the body composition variables and the effect size measured by Cohen's d varied between trivial and small.

Table 2. Comparisons of groups according to level of competition in relation to body composition variables

Dependent Variable	Group	N	M ± SD	Effect Size	p^*
Mucle mass (Kg)	Elite	13	35.7 ± 3.3	0.22	0.609
	Sub-Elite	39	34.9 ± 3.8		
	Elite	13	35.7 ± 3.3	0.39	
	Amateur	16	34.1 ± 4.7		
	Sub-Elite	39	34.9 ± 3.8	0.19	
	Amateur	16	34.1 ± 4.7		
Fat mass (Kg)	Elite	13	11.2 ± 3.1	0.03	0.826
	Sub-Elite	39	11.3 ± 3.8		
	Elite	13	11.2 ± 3.1	0.22	
	Amateur	16	12.8 ± 9.9		
	Sub-Elite	39	11.3 ± 3.8	0.20	
	Amateur	16	12.8 ± 9.9		
Total body water (L)	Elite	13	45.5 ± 4.00	0.16	0.749
	Sub-Elite	39	44.8 ± 4.69		
	Elite	13	45.5 ± 4.00	0.30	
	Amateur	16	44.0 ± 5.8		
	Sub-Elite	39	44.8 ± 4.69	0.15	
	Amateur	16	44.0 ± 5.8		
Fat free mass (Kg)	Elite	13	62.3 ± 5.49	0.18	0.722
	Sub-Elite	39	61.2 ± 6.44		
	Elite	13	62.3 ± 5.49	0.32	
	Amateur	16	60.1 ± 7.97		
	Sub-Elite	39	61.2 ± 6.44	0.15	
	Amateur	16	60.1 ± 7.97		
Body fat (%)	Elite	13	14.9 ± 3.6	0.97	0.925
	Sub-Elite	39	15.3 ± 4.2		
	Elite	13	14.9 ± 3.6	0.23	
	Amateur	16	16.3 ± 7.7		
	Sub-Elite	39	15.3 ± 4.2	0.16	
	Amateur	16	16.3 ± 7.7		

Note: * p ≤ 0.05 used in the Kruskal Wallis test; significant values and their associated effects are shown in bold. N- Number of Subjects; M- Mean; SD- Standard Deviation

Table 3 shows the analysis of lower limb power at the different competitive levels of futsal using the CMJ. In the comparisons between groups, there were only statistically significant differences between the elite and amateur groups (p < 0.001; d = 1.49), with the elite group showing better performance in the CMJ, expressed by jump height, compared to the amateur group (28.9 cm ± 3.2 vs 23.6 cm ± 3.9). However, it is important to note that the elite group showed the greatest power in the lower limbs, followed by the sub-elite group, and with the least power, the amateur group.

Table 3. Comparisons of groups according to the level of competition in relation to performance in the CMJ

Dependent Variable	Group	N	M ± SD	Effect Size	p*
CMJ (cm)	Elite	13	28.9 ± 3.2	0.47	0.188
	Sub-Elite	39	26.6 ± 6.2		
	Elite	13	28.9 ± 3.2	1.49	< 0.001
	Amador	16	23.6 ± 3.9		
	Sub-Elite	39	26.6 ± 6.2	0.58	0.211
	Amador	16	23.6 ± 3.9		

Note: * p ≤ 0.05 used in the Kruskal Wallis test; significant values and their associated effects are shown in bold. N- Number of Subjects; M- Mean; SD- Standard Deviation; CMJ- Counter Movement Jump

Finally, table 4 shows the values obtained by analysing the muscle strength of the lower limbs, based on the maximum moment of force (peak torque) of each muscle group and the ratio between knee extensors and flexors (H/Q ratio), at the different competitive levels. In this sense, we can see that the dominant lower limb recorded, on average, higher strength values in both the extensors and flexors, at all three competitive levels. The elite group had the highest peak maximum strength in both muscle groups, followed by the sub-elite group and the amateur group with the lowest peak maximum strength. However, there were only statistically significant differences between the elite and amateur groups (p = 0.047; d = 0.8) in the flexors of the non-dominant lower limb, with the elite group showing greater strength than the amateur group.

The table shows that the average H/Q ratio values (%) for all limbs and all competitive levels (< 60%) indicate a high probability of injury.

Table 4. Comparisons of groups according to the level of competition regarding performance in the isokinetic test for maximum strength values

Group	Elite (N = 13)		Sub-Elite (N = 39)		Amateur (N = 16)	
Isokinetics	Right	Left	Right	Left	Right	Left
Extenders	M ± SD					
Peak Torque (Nm)	254.5 ± 27.8 (198 – 306.8)	249.9 ± 38.7 (193.4 – 355)	234.7 ± 41.7 (149.1 – 367.8)	234.1 ± 35.6 (137.5 – 296.8)	229.7 ± 45.1 (124.1 – 314.4)	227.3 ± 53.9 (123.2 – 317.3)
Flexors	M ± SD					
Peak Torque (Nm)	138.8 ± 19,7 (109.5 – 189,1)	136.7 ± 18.4* (106.7 – 177.1)	133.2 ± 22.5 (89.2 - 181)	129.9 ± 18 (97.5 – 163.5)	127.5 ± 32.7 (73.8 – 198.5)	114.7 ± 35.3* (65.8 – 195.5)
H/Q ratio (%)	54.9 ± 8.2	55.3 ± 7.9	57.2 ± 7.2	56.3 ± 9.3	55.5 ± 8.9	50.7 ± 9.5

Note: * p ≤ 0.05 used in the Kruskal Wallis test; significant values and their associated effects are shown in bold. N- Number of Subjects; M- Median; SD- Standard Deviation; (min-máx); H/Q ratio = hamstring/quadriceps strength ratio

Discussion

Futsal is a sport that depends, to a large extent, among other things, on the adequate physical condition of its players (Ruiz-Pérez et al., 2023). Therefore, this study aimed to verify the differences in physical condition in futsal players according to their competitive level. The main conclusion of this research was that the physical condition of futsal players, defined by body composition, lower limb power and muscle strength, was significantly higher in elite players than in lower level players.

According to the literature, body composition parameters play a fundamental role in the athletic performance of futsal players (Castillo et al., 2022). Body composition assessments using bioimpedance analysis are influenced by various factors, such as environmental conditions and hydration status, and although our study adhered to a strict protocol, the incorporation of standardized checklists could further increase the accuracy and comparability of results in future research (González-Correa & Caicedo-Eraso, 2012). In the present study, as in previous investigations, we did not identify any significant differences in anthropometric characteristics between players of different competitive levels in futsal. This finding may indicate that these characteristics are relatively homogeneous between players, regardless of the level of competition.

The average age of the players ranged from 22.01 to 23.77 years, height from 1.73 to 1.76 m and weight from 72.56 to 73.32 kg; similar values have been recorded in other studies (Naser et al., 2017). In our study, elite futsal players had a lower percentage of body fat, which is in line with the study by Sekulic et al. (2020). In terms of muscle mass, elite players had higher average values and, similarly, a study of 1st, 2nd and 3rd Division futsal players in Portugal had already shown that elite athletes had higher average muscle mass values (Matias et al., 2022). With regard to fat-free mass, on average, the players evaluated had substantially higher values than those found in Belo et al. (2024) study, although he did find significant differences between sub-elite and non-elite players, with the sub-elite group having a higher fat free mass.

Previous studies corroborate these results, Lopez-Fernandez et al. (2020) found no anthropometric differences between elite and sub-elite futsal players, while Pedro et al. (2013) also found no differences between professionals and semi-professionals. On the other hand, Ayarra et al. (2018) identified differences between players from the highest competitive level (Spanish second league) and players from the lower categories (juniors), although there were no significant distinctions between the second and third league divisions. These data suggest that, although the differences are not statistically significant in many cases, elite players tend, on average, to show the best results in body composition variables, followed by sub-elite and amateur players.

This homogeneity in anthropometric characteristics may reflect the specific demands of futsal, which require high levels of physical, technical and tactical fitness at all levels of competition. However, it is important to consider that factors such as study methodology, sample size or variables analyzed may influence these results. Future studies could explore in greater depth other variables that contribute to differentiating players at different competitive levels, broadening our knowledge of performance requirements in futsal.

Lower limb muscle power is an essential and indispensable capacity for futsal players who perform numerous explosive actions during the game (Gorostiaga et al., 2009; Naser & Ali, 2016). Our study used an indirect analysis of muscle power obtained by measuring the maximum height reached on the CMJ (Naser et al., 2017). Elite futsal players performed better on the CMJ compared to lower level players, and the differences between elite and amateur levels were significant. Corroborating our results, in the study by García-Unanue et al. (2020), elite players also performed better than amateur players. At the same time, Naser & Ali (2016) found no significant differences in CMJ between the different competitive levels. The average height of the CMJ of the elite players in this study was substantially lower than that found in other previous studies (Gorostiaga et al., 2009; Cuadrado-Peñafiel et al., 2014; Naser & Ali, 2016; Loturco et al., 2022).

The muscle balance between the flexors and extensors of the knee joint is fundamental, with the quadriceps muscle group playing a decisive role in kicking and jumping. At the same time, the hamstrings control running and provide a protective mechanism for the knee during changes of direction and tackles (de Lira et al., 2017). In our study, elite futsal players (136.7 ± 18.4 Nm) showed significant differences in the strength of the hamstrings of the non-dominant limb compared to amateur futsal players (114.7 ± 35.3 Nm). Similarly, Cometti et al. (2001) also found that elite soccer players had greater hamstring strength than amateur players. According to Spyrou et al. (2020), the dominant limb seems to be stronger, reaching higher maximum strength values, as was the case in our study, at all competitive levels, it was in the dominant limb that higher maximum strength values were recorded, both in extensors and flexors.

Isokinetic assessment is one of the most widely discussed and requested methods for assessing injury risk, and the H/Q ratio is a useful variable for helping to identify muscle imbalances in futsal players (Croisier et al., 2008). The results of our study are similar to those of de Lira et al. (2017), in which the average values of the H/Q ratio (%) in both limbs and at all competitive levels indicate a high probability of injury, since according to Aagaard et al. (1998) values below 60%, as in our case, increase susceptibility to injury. On the other hand, Ferreira et al. (2017) suggest that injury prevention strategies should focus on the normative value of 60% for an isokinetic angular velocity of 60º/s (as in our case). According to Croisier et al. (2008) muscle strength imbalances put a player on average 4.6 times more at risk of developing a hamstring injury, so our results alert us to this possibility in the futsal players assessed, highlighting the need for early intervention in muscle balance.

As for the limitations of this study, the size of the sample, particularly in the Elite and Amateur groups, does not allow us to draw generalised conclusions for the other teams participating at these competitive levels, as well as the fact that the evaluation was carried out at the start of a season, when the players are after their longest competitive break and have not yet undergone the positive changes of the demands of their competition, as well as the lack of research in the area that allows a comparative link in terms of results. In this sense, future studies should try to increase the sample size to improve the power of the result and its interpretation, and should include more teams at different competitive levels and different stages of the season.

Conclusions

In conclusion, elite players showed more lower limb power and muscle strength than players at lower levels. These results can be explained by better training planning, with higher and more intense loads, along with more complex competitive schedules. We found no differences in body composition between groups in this sample.

The results highlight an alarming risk of lower limb injuries at all competitive levels (H/Q ratio < 60%), emphasising the importance of individualised analysis of physical condition and injury predictors at this stage of the season and highlighting the need for more research into this emerging topic in futsal.

Practical implications

• In light of the results of this study, it seems necessary for futsal coaches, physical trainers and physiotherapists to prioritise strength training in daily training routines based on the individual needs of each player, regardless of the level of competition in which they participate, in order to reduce the likelihood of injury occurring. Injury risk reduction programmes using hamstring strength training can be useful for improving the H/Q ratio.

• It is hoped that futsal coaches, physical trainers and physiotherapists will be able to use the results of this study as a tool for a better understanding of the various physical condition variables, in terms of body composition, lower limb power and muscle strength, at each competitive level of futsal, and thus determine what can be enhanced to improve sports performance.

Author Contributions

C.M. worked on Conceptualization, Formal Analysis, Visualization, Writing – original draft, Writing – review & editing. M.R. worked on Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. R.C. worked on Conceptualization, Data curation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. M.B. worked on Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. R.P. worked on Conceptualization, Data curation, Formal Analysis, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. P.D-M worked on Conceptualization, Data curation, Formal Analysis, Investigation, Methodology. S.H. worked on: Project administration, Resources. J.S. worked on Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Instituto Politécnico de Castelo Branco (134/CE-IPCB/2023).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are only available upon request from the corresponding author. The data are not publicly available due to privacy issues.

Disclosure statement

The author reported no potential conflict of interest.

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