

The influence of playing position on physical performance variables in young handball players

João Ribeiro¹, Jorge Moreira², Samuel Campos³, Vitor Vinagre⁴, Alexandra Malheiro⁵, Pedro Afonso⁶

^{1, 2, 3, 4, 5, 6}Department of Sports, Higher Institute of Educational Sciences of the Douro, Penafiel, Portugal

^{5, 6}CI-ISCE, ISCE Douro, Penafiel, Portugal

¹Corresponding author

E-mail: ¹joaopsribeiro1112@gmail.com, ²danysoares1235@gmail.com, ³campossamuel352@gmail.com, ⁴vitorsamuelvinagre@gmail.com, ⁵alexandramalheiro.work@gmail.com, ⁶pmvafonso@gmail.com

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Abstract. 2. This study aimed to analyse the influence of playing position on selected physical performance variables in young male handball players. It was hypothesised that playing position would influence physical performance variables in young handball players, namely VO₂max, jump power and handgrip strength, particularly right-hand grip strength, due to the different physical, technical and tactical demands associated with each playing position. The sample consisted of 16 athletes from the same team, with a mean age of 14.0±0.7 years, distributed across five playing positions: wing, pivot, centre, goalkeeper and back. Aerobic capacity was assessed through the Yo-Yo Test, from which VO₂max was estimated. Jump power was measured using a force plate, while handgrip strength was assessed with a hand dynamometer for both right and left hands. Descriptive statistics were used to characterise the sample, and the Kruskal-Wallis test was applied to compare performance variables between playing positions. The results showed no statistically significant differences between positions for VO₂max, jump power or left-hand grip strength. However, a significant difference was found for right-hand grip strength, with higher values observed in backs and goalkeepers. Therefore, the results partially confirmed the hypothesis, as playing position appeared to influence right-hand grip strength, but not all the physical performance variables analysed. Although some positional trends were identified, the small sample size requires cautious interpretation. These findings suggest that playing position may influence specific physical performance characteristics in youth handball, supporting the importance of individualised and position-specific training programmes.

Keywords: handball, playing position, physical performance, VO₂max, jump power, handgrip strength, youth athletes.

1. Introduction

Handball is an intermittent team sport of high intensity [1] and strong neuromuscular demand [2], characterised by alternation between offensive and defensive actions, multidirectional movements [3], accelerations and decelerations [4], jumps [5], throws/shots [6], rapid changes of direction [4], physical contacts and short recovery periods [1]. As the technical and tactical tasks differ between wings, backs/centres, pivots and goalkeepers, playing position may influence the external load profile, physiological intensity, strength and power of young handball players [7].

Goalkeepers have a highly specific role, associated with reaction speed [8], defensive positioning [9], mobility and the rapid execution of specific movements [10], and the ability to anticipate shooting situations [11]. Wings tend to stand out for their speed, acceleration, agility, jumping ability and capacity to perform fast breaks [7]. Backs require greater power, strength, stature and throwing velocity due to the frequency of long-distance shots and physical contact [12]. The centre player presents a more balanced profile, combining endurance, coordination, agility and rapid changes of direction [13]. Finally, the pivot is characterised by greater body mass, strength, balance and stability, due to the need to operate in areas of high physical contact near the

six-metre line [14]. These differences justify the need for position-specific physical preparation, especially in young players, whose maturation and physical development may still influence performance [15].

In young players, this analysis should consider growth, biological maturation and progressive specialisation, as these factors influence indicators of aerobic fitness, strength, speed, power and overall performance [16]. VO_2 , expressed as VO_{2max} or VO_{2peak} , represents the athlete's cardiorespiratory capacity and is relevant in handball because it facilitates recovery between intense efforts, helps maintain intensity throughout the match and improves fatigue tolerance, particularly in positions with a greater volume of movement and transitions [7], [16]. Therefore, positional differences in VO_2 may reflect not only general fitness, but also the specific demands of each playing role.

Jump power is determinant for explosive lower-limb actions, including jump shots, blocks, jumps, accelerations and changes of direction. The countermovement jump and other jump tests are useful for assessing explosive capacity in handball players, and plyometric interventions have been shown to improve jumping ability, speed and change-of-direction performance [2], [5]. Furthermore, jumping ability is related to throwing velocity and accuracy, reinforcing its importance for offensive performance [6].

Handgrip strength is a simple and functional measure of upper-limb strength, relevant for gripping, controlling, protecting and throwing the ball. The assessment of handgrip strength, including the right hand, allows differences associated with laterality, hand dominance and positional specialisation to be observed, and may also reveal useful asymmetries for training planning [2], [5]. Thus, the present study aims to analyse the influence of playing position on VO_2 , jump power and handgrip strength, with particular attention to the right hand, in young handball players, contributing to a more individualised training prescription adjusted to the real demands of each position.

This study aims to determine whether playing position influences the physical performance of young handball players through the analysis of VO_2 , jump power and handgrip strength, particularly of the right hand, in order to better understand the specific physical demands of each position. Playing position is expected to influence physical performance variables in young handball players, namely VO_2 , jump power and handgrip strength, particularly right-hand grip strength, due to the different physical, technical and tactical demands associated with each playing position

2. Methodology

2.1. Study design

This study employs an observational, cross-sectional, descriptive and comparative design, with the aim of analysing physical performance variables in young handball players, as well as comparing these variables according to playing position.

2.2. Sample

The sample consisted of 16 young male handball players from the same team, with an average age of 14.0 ± 0.7 years. The following playing positions were considered: wing, pivot, centre, goalkeeper and wing-back. The general characteristics of the sample were analysed using descriptive statistics, including age, years of experience, VO_{2max} , jump power and right and left hand grip strength.

2.3. Procedures

Data were collected individually for each athlete and subsequently organised into a database

for statistical analysis. All tests were applied under standardised conditions, with the same procedures used for all participants, in order to improve the reliability of the measurements.

Aerobic capacity was assessed using the Yo-Yo Intermittent Recovery Test, from which $VO_2\text{max}$ was estimated according to the distance achieved. This field test was selected because it is specifically designed to assess the ability to perform repeated high-intensity intermittent exercise, which is consistent with the physiological demands of handball. Previous research has shown that the Yo-Yo intermittent tests are valid tools for evaluating intermittent endurance capacity and aerobic fitness in team-sport contexts, and a systematic review reported good-to-excellent test-retest reliability across Yo-Yo test variants [17-19]. Therefore, the estimated $VO_2\text{max}$ values were considered appropriate for comparing cardiorespiratory performance between playing positions.

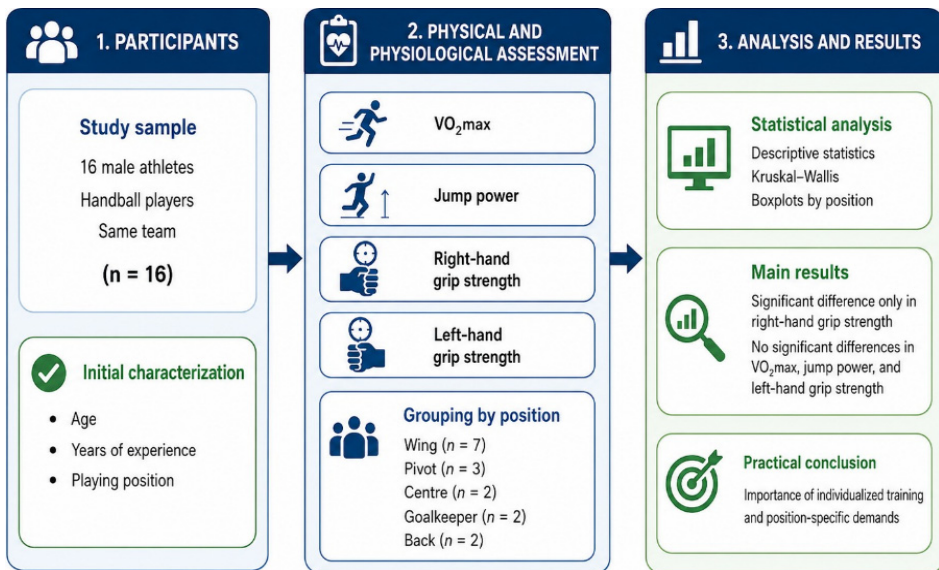


Fig. 1. Study flowchart

Jumping power was assessed using a force plate through a vertical jump protocol. The force plate records force-time data and allows the objective calculation of jump-related variables, such as jump height, force production and power output. Countermovement jump assessments performed on force plates have been widely used to evaluate lower-limb neuromuscular performance, and previous studies have reported acceptable reliability of force-time variables when the testing protocol is standardised [20], [21]. For this reason, the force plate was considered a suitable and reliable instrument for assessing explosive lower-limb performance in young handball players.

Handgrip strength was assessed using a hand dynamometer, with values for the right and left hands recorded separately. Hand dynamometry is a practical, valid and reliable method for assessing maximal isometric grip strength and is commonly used in sport performance assessment. Previous studies have demonstrated high test-retest reliability for handgrip strength measurements in children, adolescents and athletes, including both preferred and non-preferred hands [22], [23]. Recording both hands separately also allowed the analysis of lateral differences, hand dominance and possible asymmetries relevant to ball control, gripping and throwing actions in handball.

2.4. Statistical analysis

Statistical analysis was performed using JASP software. Initially, a descriptive analysis of the variables was carried out, using the mean, standard deviation, median, interquartile range,

minimum value and maximum value. To compare the physical variables between playing positions, the Kruskal-Wallis test was used, with a significance level of $p < 0.05$. Effect sizes were also analysed, namely epsilon squared (ϵ^2) and the correlation coefficient (η), to complement the interpretation of the results.

3. Results

The main findings obtained from the descriptive and comparative analysis of the variables assessed. First, a general characterisation of the sample is provided, taking into account age, years of experience, VO₂max, jump power, and right and left hand grip strength (Table 1).

Table 1. Descriptive analysis of the study variables

Variable	Mean ± SD	Median [Q1-Q3]	Min-Max
Age (years)	14.0±0.7	14.0 [14.0-14.0]	12.0-15.0
Years of experience	2.9±1.7	2.0 [2.0-3.2]	1.0-7.0
VO ₂ max	49.2±7.4	45.7 [43.8-54.3]	40.2-63.6
Jump power	758.2±146.8	737.7 [686.5-817.8]	560.9-1099.0
Handgrip strength – right hand	36.6±5.9	36.7 [32.5-40.2]	26.8-48.4
Handgrip strength – left hand	34.6±4.9	34.2 [30.5-38.0]	27.2-44.4

Note. SD = standard deviation; Q1 = first quartile; Q3 = third quartile. Units for VO₂max, jump power, and handgrip strength should be reported according to the protocol and instruments used.

The sample had a mean age of 14.0±0.7 years and an average of 2.9±1.7 years' experience. With regard to physical variables, VO₂max had a mean of 49.2±7.4, whilst jump power recorded a mean of 758.2±146.8. With regard to handgrip strength, the mean was 36.6±5.9 for the right hand and 34.6±4.9 for the left hand. These results provide an overall characterisation of the sample in terms of age, sporting experience and physical performance.

Table 2. Comparison of physical performance variables according to playing position

Variable	Wing (n = 7)	Pivot (n = 3)	Centre (n = 2)	Goalkeeper (n = 2)	Back (n = 2)	H(4)	p	ϵ^2	η
VO ₂ max	47.3±5.5	51.5±11.7	60.2±0.0	44.4±1.3	45.8±0.0	4.87	0.301	0.08	0.66
Jump power	677.2±87.1	736.4±181.7	768.0±53.3	799.7±77.2	1023.1±107.4	7.30	0.121	0.30	0.77
Handgrip strength – right hand	34.5±3.3	39.7±2.5	27.0±0.3	41.8±2.8	43.6±6.7	10.37	0.035	0.58	0.87
Handgrip strength – left hand	32.6±4.5	36.3±1.6	32.6±7.6	38.0±1.1	37.4±9.9	3.73	0.443	0.00	0.47

Note. Values by position are presented as mean ± standard deviation. H = Kruskal-Wallis test statistic; ϵ^2 = effect size based on the Kruskal-Wallis test; η = correlation ratio, used as a descriptive measure of the association between a nominal variable and a continuous variable. Because some groups included only two athletes, the results should be interpreted as exploratory.

Table 2 presents a comparison of physical variables according to playing position. It was found that VO₂max did not show any statistically significant differences between positions, although central players had higher mean values. No significant differences were observed in jump power either, although full-backs had the highest mean values for this variable. With regard to right-hand grip strength, a statistically significant difference was observed between positions, with $p = 0.035$, with the highest values recorded for full-backs and goalkeepers and the lowest for centre-backs. On the other hand, left-hand grip strength showed no statistically significant differences between positions.

The VO₂max graph (Fig. 2) indicates that central midfielders had the highest values, whilst goalkeepers and full-backs showed lower and more homogeneous values. The wingers showed

some variation, with intermediate values and one player recording a higher value. These results suggest that aerobic capacity may differ between positions, although the small size of the groups limits definitive conclusions.

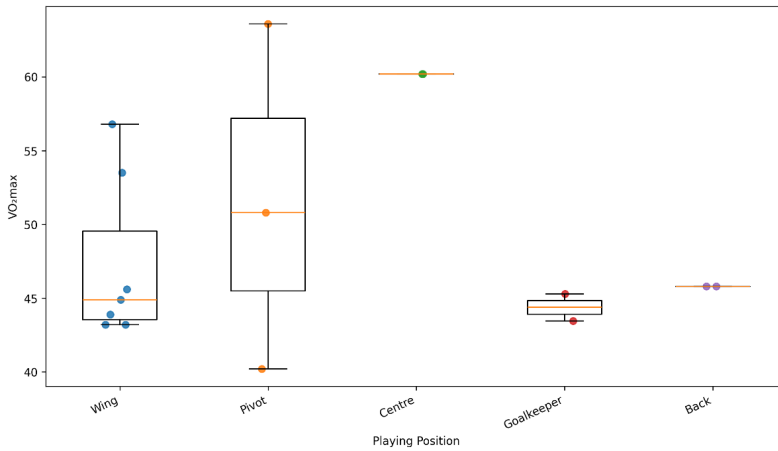


Fig. 2. VO₂max by position

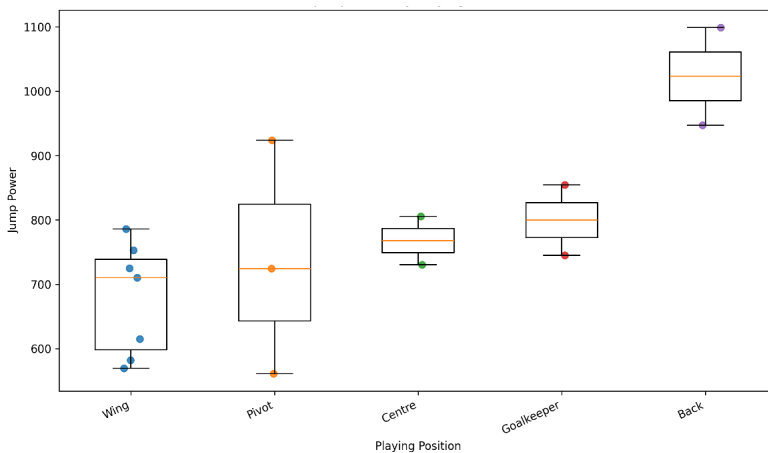


Fig. 3. Jump power by position

In the jump power graph (Fig. 3), the full-backs stood out with the highest values, followed by the goalkeepers and centre-backs. The wingers showed lower values and some variability, whilst the centre-forwards displayed a wider distribution. Overall, the graph suggests that jump power may be associated with the specific demands of each position, but the results should be interpreted as exploratory.

The graph of right-hand grip strength (Fig. 4) shows visual differences between the positions. Players in the wing and goalkeeper positions tended to have higher values, whilst centre-backs recorded the lowest values. This trend suggests that right-hand grip strength may vary depending on playing position, although interpretation should be cautious due to the small number of players in some groups.

In the graph showing left-hand grip strength (Fig. 5), the differences between positions appear less pronounced than for the right hand. Nevertheless, goalkeepers, full-backs and pivots recorded slightly higher values, whilst wingers and centre-backs showed lower values or greater variability. These results suggest a positional trend, but without visual evidence as clear as that seen for the right hand.

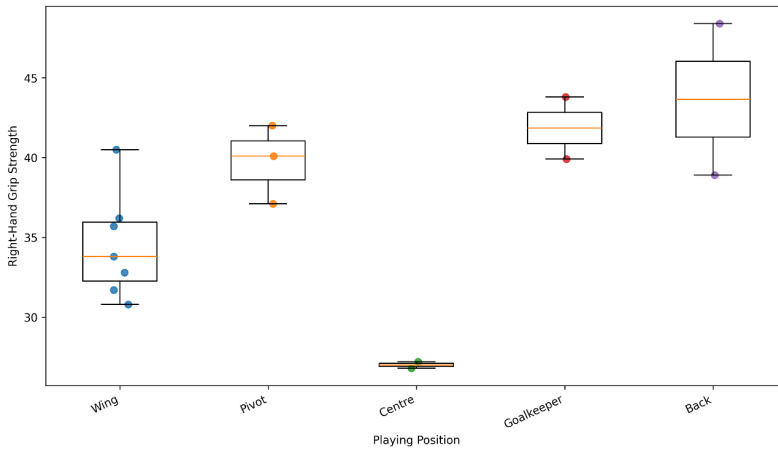


Fig. 4. Right-hand grip strength by position

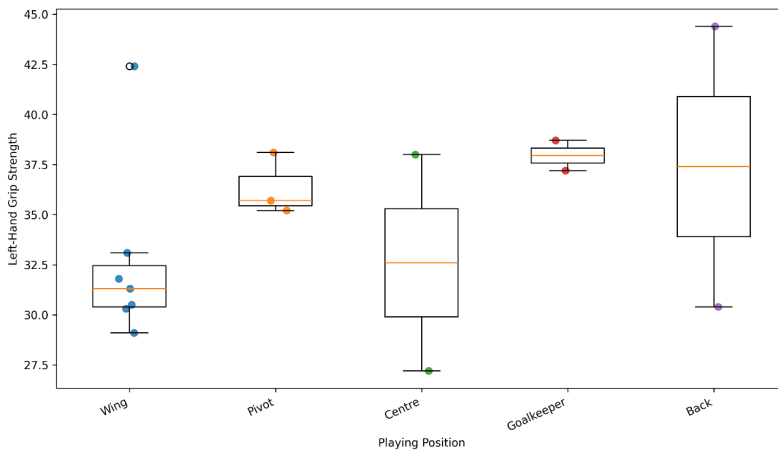


Fig. 5. Left-hand grip strength by position

4. Discussion

The present study analysed selected physical performance variables according to playing position in youth male handball players. In the current sample, no statistically significant differences were observed between playing positions for VO_2 max, jump power, or left-hand grip strength, whereas right-hand grip strength showed a significant positional difference (present study). The descriptive results also suggested that centre players presented higher VO_2 max values, backs showed higher jump power values, and backs and goalkeepers tended to present higher right-hand grip strength values (present study). These results should be interpreted with caution due to the small sample size and the unequal number of players across positions (present study).

It was hypothesised that playing position would influence physical performance variables in young handball players, namely VO_2 , jump power and handgrip strength, particularly right-hand grip strength, due to the different physical, technical and tactical demands associated with each playing position. The results partially confirmed this hypothesis, as a statistically significant difference was found only for right-hand grip strength, while VO_2 , jump power and left-hand grip strength did not show statistically significant differences between playing positions. Therefore, the hypothesis was partially supported, suggesting that playing position may influence specific physical characteristics, especially upper-limb strength, but not all the physical performance variables analysed.

These findings are consistent with previous research showing that physical fitness attributes in handball can vary according to playing position [24]. Previous studies have shown that handball players from different positions may present distinct anthropometric, maturational, and physical performance characteristics, especially in youth athletes [25]. Research in elite handball has also demonstrated that match-play physiological demands differ between positions, supporting the idea that each playing role imposes specific physical requirements on the athlete [26].

The tendency for backs to present higher jump power in the present study may be explained by the specific offensive demands of this position, which often involve powerful jumps, long-range shots, and explosive actions [27]. The higher right-hand grip strength observed in backs and goalkeepers may also reflect the relevance of upper-limb strength in actions such as throwing, blocking, and ball control [24]. Previous research has highlighted handgrip strength, vertical jump performance, and throwing-related capacities as relevant physical indicators in handball players, reinforcing the importance of assessing these variables according to positional role [27].

Although most differences were not statistically significant, the observed trends suggest that players may present different physical profiles even within the same team and age group [25]. This reinforces the importance of individualised training prescription, since applying the same training stimulus to all players may not adequately address the specific needs of each athlete [28]. In team handball, performance depends not only on collective tactical organisation but also on the individual physical, technical, and positional characteristics of each player [28].

From a practical perspective, the present results support the need for position-specific and individualised training programmes. Coaches should consider the physical demands of each playing position when planning training, such as aerobic capacity development for players with greater movement involvement, jump power for positions requiring explosive offensive actions, and upper-limb strength for positions with greater throwing, blocking, or ball-control demands [26], [27]. Individual monitoring is particularly important in youth athletes, because maturation, training experience, and positional specialisation can influence physical development and performance outcomes [25].

In conclusion, the findings of the present study suggest that positional differences in youth handball may be more evident in right-hand grip strength, while other variables showed only descriptive trends (present study). Even when statistical significance is limited, the analysis of individual and positional profiles remains useful for guiding training decisions and improving the specificity of training prescription [24], [28]. Therefore, training programmes in youth handball should respect both the individual characteristics of each athlete and the specific demands of their playing position [26], [28].

5. Conclusions

The present study suggests that playing position may influence selected physical performance variables in young handball players. Although VO_2 max, jump power and left-hand grip strength did not show statistically significant differences between positions, relevant descriptive trends were observed. Centre players presented higher VO_2 max values, backs showed greater jump power, and backs and goalkeepers recorded higher right-hand grip strength. The only statistically significant difference was found for right-hand grip strength, indicating that upper-limb strength may be more position-dependent in this sample. These findings reinforce the importance of individualized and position-specific training in youth handball. However, due to the small and unequal sample size across positions, the results should be interpreted with caution. Future studies with larger samples are needed to confirm these positional differences.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author contributions

João Ribeiro: Conceptualization, data collection, statistical analysis, data interpretation, and writing-original draft preparation. Samuel Campos: Investigation and writing-review and editing. Vítor Vinagre: investigation and writing-review and editing. Jorge Moreira: investigation and writing-review and editing. Alexandra Malheiro: supervision and writing-review and editing. Pedro Afonso: Supervision and writing-review and editing. All authors have read and approved the final version of the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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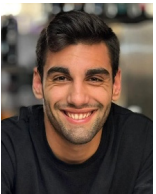
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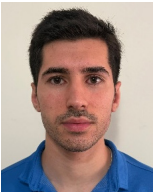
João Ribeiro holds a bachelor's degree in Sports and is currently pursuing a master's degree in physical Activity, Sport and Well-being at ISCE Douro, Portugal. He is a handball coach at Clube Andebol de Penafiel and a former handball player. His academic and professional interests focus on handball, youth athlete development, physical performance assessment, training methodology, and sports performance analysis.



Jorge Moreira holds a degree in Sport from ISCE Douro and is currently completing a master's degree in physical Activity, Sports, Health and Well-Being. He works as a certified Personal Trainer and Online Coaching specialist. His academic and professional interests focus on muscle hypertrophy, body composition, physical performance, health, and fitness, combining evidence-based practice with ongoing academic training.



Samuel Campos holds a degree in Sport from ISCE Douro and is currently pursuing a master's degree in physical Activity, Sport and Well-being. He works in a fitness centre, supporting individuals in improving physical fitness, health, and active lifestyles, while also working as a football coach. His main interests focus on football, athlete development, physical conditioning, and sports performance.



Vítor Vinagre holds a degree in Sport and is currently pursuing a master's degree in physical Activity, Sport and Well-being. He has worked as a Personal Trainer at Playlife for over one year, performing exercise assessment, prescription, and monitoring. His professional interests focus on individualized training, physical fitness, health, well-being, and quality of life. He has a particular interest in athletes' physical preparation, especially in football, with the aim of contributing to performance, injury prevention, and physical development.



Alexandra Malheiro holds a Ph.D. in sports science and is a lecturer at the ISCE Douro. She has academic training in Physical Education and Sport, as well as Marine Sciences. Her work focuses on exercise assessment and prescription, physiology, biomechanics, functional training, and sports coaching. She is also a basketball coach and Pilates instructor.



Pedro Afonso is a Physical Education teacher, professor at IP Portalegre and ISCE Douro, and a PhD student in Sports Sciences at the University of Trás-os-Montes and Alto Douro, Portugal. He holds a UEFA B football coaching license and has experience as a football coach in different youth categories. His academic and professional interests focus on sports sciences, physical education, coaching, training methodology, and youth athlete development.