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Comparison of jump height and lower body power among semi-professional handball and basketball players in Cantabria as a function of position and gender

Comparación de altura de salto y la potencia del tren inferior entre jugadores de balonmano y baloncesto semiprofesionales cántabros en función de la posición y el género

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Abstract

The objectives of the research were (1) to perform a descriptive analysis to compare jump height and lower body power between basketball and handball players according to gender and (2) to identify the position of the player with the greatest intradepartmental power. A descriptive analysis of jump height and lower body power, a capacity considered decisive in handball and basketball sports, was carried out. By means of the OptoGait® tool, jump height and lower body power were evaluated by means of the countermovement jump test (CMJ) in a total of 49 subjects distributed in 4 teams, 2 basketball teams, one male and one female, and 2 handball teams, one male and one female. The results show that men obtained higher jump and power results than women in both sports, that the parameters of jump height and power between basketball and handball are similar but the higher the category, the higher the jump and power values. For the male gender, the handball position with the highest jump height is the wing and for basketball, it is the small forward, in the female gender, the wingers obtained the highest results in handball as well as the small forward in basketball. However, differences were found in the position with the highest power between genders. The position that obtained the greatest difference in power was the handball pivots and for basketball, the pivots. It is concluded that according to gender there is no difference between sports in athletes from Cantabria. The results do not adjust to the scientific reality, this may be due to the difference in category between the teams of the sample obtained and to the anthropometric profile of the players.

Keywords: optoGait, countermovement jump, handball; basketball, vertical jump.

Resumen

Los objetivos de la investigación fueron (1) realizar un análisis descriptivo para comparar la altura de salto y la potencia del tren inferior entre jugadores de baloncesto y balonmano en función del género e (2) identificar la posición del jugador con mayor potencia intradeporte. Se realizó un análisis descriptivo de la altura de salto y potencia del tren inferior, capacidad considerada determinante en los deportes de balonmano y baloncesto. Por medio de la herramienta OptoGait®, se valoró la altura de salto y la potencia del tren inferior mediante el test de salto con contramovimiento (CMJ), a un total de 49 sujetos distribuidos en 4 equipos, 2 de baloncesto uno masculino y otro femenino y 2 de balonmano de igual manera uno masculino y otro femenino. Los resultados evidencian que los hombres obtuvieron resultados más elevados de salto y potencia que las mujeres en ambos deportes, que los parámetros de altura de salto y

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potencia entre el baloncesto y en balonmano son similares pero cuanto mayor es la categoría mayores son los valores de salto y potencia. Para el género masculino la posición de balonmano con mayor altura de salto, es el extremo y para el baloncesto, son los aleros, en el género femenino, las extremos obtuvieron un los resultados más altos en balonmano al igual que las aleros en baloncesto. Sin embargo, se encontraron diferencias en la posición con mayor potencia entre géneros. La posición que obtuvo la mayor diferencia en la potencia, fueron las pivotes de balonmano y para baloncesto, las pivots. Se concluye que según el género no existe diferencia entre los deportes en deportistas de Cantabria. Los resultados no se ajustan a la realidad científica, esto puede ser debido a la diferencia de categoría existente entre los equipos de la muestra obtenida y al perfil antropométrico de los jugadores.

Palabras clave: optoGait, salto con contramovimiento, balonmano; baloncesto, salto vertical.

Introduction

Handball and basketball according to the classification of Parlebas (2001) are sports of cooperation and opposition with low uncertainty (CAI) that are practiced in a stable environment (Panchuk et al., 2018). The efforts that demand the specificity of such sports are of intermittent character, generally less than three seconds, combining periods of activity at high and moderate intensities (Sánchez Ballesta, et al. 2019; Piedra et al., 2021; Khortabi et al., 2023), with the high intensity anaerobic type being those that cause greater fatigue and therefore have a greater effect on the performance of this type of athlete (Delextrat & Cohen, 2008; Oliveira da Silva, et al., 2013; Khortabi, et al., 2023).

Manifestations of anaerobic efforts are presented in competition as the following technical gestures: vertical jump, sprint, change of pace and direction, dribbling, feints, stops (Krykant & Buško, 2017; Oliveira da Silva, et al., 2013). A good lower body power capacity in the execution of game actions, is differential against the opponent, being of lesser importance the maximum speed of the players (Šimonek, 2017) as opposed to the sprint that is more determinant, representing one of the main performance factors (Chaouachi et al., 2009; Ishak et al., 2022) where body composition has a determining effect on the manifestation of relative power (Chaves et al., 2023).

In this sense, both handball and basketball players adopt a series of positions with specific characteristics, generally associated with certain anthropometric profiles

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and, consequently, with a different demand of physical capacities (Vaquera et al., 2015; Vila et al., 2012; Rösch et al., 2020). In addition, the different conditional capacities, due to the reiteration of the motor actions that occur in competition, have a greater influence in some positions than in others (San Román-Quinta et al., 2011; Rösch et al., 2020; Ibáñez, et al., 2023). This aspect is determinant for coaches and/or physical trainers when planning training (Ferioli et al., 2018).

Thus, taking into account that one of the most determinant aspects of performance is sprinting and that this is directly correlated with horizontal jumping (Chaouachi et al., 2009; Otero et al., 2013), the use of the countermovement jump (CMJ) as an instrument for the evaluation of lower body power to predict performance in sports that demand intermittent high intensity efforts with low recovery periods, represents one of the most appropriate, reliable and valid tests (Rodríguez-Rosell et al., 2017), in addition, the power recorded in the CMJ is directly related to acceleration (Northeast, 2019). This tool also has the advantage of low cost of human resources and the application of the test in a short period of time (Markovic et al., 2004). Dal Monte et al. (1987) carried out one of the first comparative studies between basketball and handball where, among other aspects, lower body power was evaluated through the CMJ. In this study, the results on the explosive muscular strength of the lower body between the two sports were similar and at the same time inferior to other sports such as volleyball. Later Pontaga and Zidens (2018) also continued conducted a study on this topic in Latvia concluding that Latvian high level basketball and handball players are similar and at the same time comparable with the results of countermovement jumping tests of international level players of both sports games. On the other hand there is evidence that the players who have more vertical jump demands and therefore have higher lower body power are basketball players (Baljinder et al., 2014).

However, other more recent studies indicate that jump height in handball is superior (Pontaga & Zidens, 2018).

As a general rule, it is also known that there are significant differences in lower body power according to gender, with lower parameters in women's sport than in men's (Silva et al., 2014; Mateluna-Núñez et al., 2022; León et al., 2023).

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The scientific literature also determines that the power developed by players varies according to the different positions (Rösch et al., 2020; Ibáñez et al., 2023), specifically the player with the greatest jumping power in basketball is the point guard (Pehar et al., 2017), and in handball it is the center backs (Massuca et al., 2015).

Therefore, the objectives of this study were: (1) to perform a descriptive analysis to compare jump height and lower body power between basketball and handball players according to gender and (2) to identify the position of the player with the highest intradepartmental power.

Material and Method

Design and sample

The research was a quantitative cross-sectional study whose independent variables were defined as gender, sport and intrathletic position, and the power and jumping height of the CMJ were defined as dependent variables.

The sample corresponding to Table 1, was recruited by convenience and opportunity, was constituted by 49 subjects categorized as performance level 3 according to the classification of McKay et al. (2021), they were distributed in 4 teams, one team for each gender and sport discipline. A 24.49% (12) of male handball, these athletes were playing in silver honor division (2nd national category). 30.61% (15) corresponded to women's handball, which participated in the honor division (1st national category). Another 22.45% (11) represented men's basketball, which competed in the EBA league (4th national category). Finally, the remaining 22.45% (11) were women's basketball players, who were in the first division (3rd national league).

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Table 1.

Distribution of the sample by teams and their category according to gender

Team	Category	Sample
Men's Handball	Silver Handball Division	24,40% (10)
Women's Handball	Upper Division	20,61% (15)
Men's Basketball	EDA League	22,45% (11)
Women's Basketball	First division	22,45% (11)

Instruments

The measuring tool used was the OptoGait® V1.12.19.0 (Bolzano - Italy), a system equipped with optical sensors with a frequency of 1000 Hz, with an accuracy of 1 cm and consisting of a transmitter and a receiver bar, with 96 infrared LEDs connected together, with a maximum separation of 6 meters. Each interruption of the photocells the tool made a record, thus finding the flight time and jump height. Its statistically significant validity values (95 % CI = 0.92-0.99; $p < .001$) (Lee et al., 2014).

Figure 1 shows the protocol established with the selected sample..

Figure 1.

CMJ protocol image



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Procedure

Data collection was performed homogeneously in all the teams included in the study during the competitive period and selecting a training day without fatigue bias.

All study participants were provided with an information sheet of the test they were going to carry out with its respective protocol. This protocol consisted of performing a vertical jump without an arm swing and the hands were fixed to the hips from start to finish. On the other hand, at the highest point of the jump the hip was kept in neutral position, the knees fully extended and the ankle in plantar flexion position. Three jumps were performed by each subject, non-consecutive, leaving a minimum of 1 minute and 30 seconds between jumps to avoid the potential post-activation of the next repetition, the maximum height data of the different attempts was used. The test was performed in groups of 3 people, performing the jump alternately.

The subjects performed the jump at the investigator's signal once the body was placed inside the measuring platform. Jumps with a poorly applied technique, not corresponding to the protocol, were discarded without being repeated. The different teams performed the test on different days.

Likewise and together with the test protocol, all study participants received the research information sheet and informed consent. All research data were collected at the sports club facilities in April 2021.

Statistical analysis

Descriptive statistical analysis was performed using JASP Team (2020) software (Version 0.14.1) [Computer software] by Goss-Sampson, (2018). The comparative analysis focused on jump height (cm), lower body power (W), gender (male and female) and playing position, intrasport. The dependent variable of jumping, jump height, was measured through the OptoGait® measurement tool and its specific software (Version V1.12.19.0), which analyzed jump height and flight time (Biasi, 2018).

A descriptive analysis of the variables, both dependent and independent, was also performed. Following the work model carried out by Romero et al. (2014), the main reason for the study was to carry out a descriptive analysis that reflected the reality of

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lower body power in the context of sport in the Autonomous Community of Cantabria, in addition to describing which intradepartmental position obtained the highest jump height and power. For this purpose, the frequencies of the mean values by positions of each team were calculated.

Ethical aspects

The study followed the ethical and deontological principles established by the American Psychological Association (American Psychological Association, 2020), as well as the ethical recommendations for educational research (Paz, 2018).

Approval of the research protocol was requested from the Ethics Committee of the European University of the Atlantic, which was approved under code CEI11/2021 and signed dated April 2021.

Results

The results obtained from the CMJ of the male handball players, evidenced that they have a mean jump height of 41.950 ± 7.616 cm. The mean power of the team was 2510.625 ± 283.166 W. The maximum value was 59.900 cm (extreme) and the minimum value was 31.500 cm (central) in jump height. The maximum power was 2982.272 W of the goalkeeper and the minimum 1902.253 W of the center back (Figure 2).

Figure 2.

Men's handball descriptive statistics of maximum CMJ (cm), power (W) and relative power (w/kg).

	CMJ max	Potencia	Potencia relativa
Valid	12	12	12
Missing	0	0	0
Mean	41.950	2510.625	28.044
Std. Deviation	7.616	283.166	2.476
Minimum	31.500	1902.253	24.388
Maximum	59.900	2982.272	33.630

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The handball players obtained a CMJ result of 25.333 ± 5.081 cm, and an average power of 1459.473 ± 252.778 W. The maximum values of the test were 37.200 cm (end) and 1947.682 W (pivot). Conversely, the minimum was 19.500 cm (lateral) and 1187.838 W (goalkeeper). The details of these results are shown in Figure 3.

Figure 3.

Descriptive statistics for women's handball of maximum CMJ (cm), power (W) and relative power (w/kg).

	CMJ max	Potencia	Potencia relativa
Valid	15	15	15
Missing	0	0	0
Mean	25.333	1459.473	21.776
Std. Deviation	5.081	252.778	2.110
Minimum	19.500	1187.838	19.188
Maximum	37.200	1947.682	26.503

The men's basketball team had a mean jump height of 40.455 ± 6.179 cm and a mean power of 2346.176 ± 165.139 W. The player with the highest jump height had a CMJ score of 48.300 cm (small forward) and the player with the highest power of the group had 2621.501 W (small forward). While the minimum value for jump height was 26.500 cm (center) and for power 2067.283 W (point guard) (Figure 4).

Figure 4.

Men's basketball descriptive statistics of maximum CMJ (cm), power (W) and relative power (w/kg).

	CMJ max	Potencia	Potencia relativa
Valid	11	11	11
Missing	0	0	0
Mean	40.455	2346.176	27.558
Std. Deviation	6.179	165.139	2.201
Minimum	26.500	2067.283	22.369
Maximum	48.300	2621.501	30.199

The players of the women's basketball team obtained a mean value of 26.245 ± 5.082 cm for jump height, and a mean value of 1424.014 ± 210.132 W. Likewise, the maximum value that a player showed was 37.200 cm (forward) and 1823.824 W

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(center) for jump height and power, respectively. However, the minimum value that a player showed was 18.500 cm (center) and 1070.339 W (shooting guard) (Figure 5).

Figure 5.

Women's basketball descriptive statistics of maximum CMJ (cm), power (w) and relative power (w/kg).

	CMJ max	Potencia	Potencia relativa
Valid	11	11	11
Missing	0	0	0
Mean	26.245	1424.014	22.169
Std. Deviation	5.082	210.132	2.126
Minimum	18.500	1070.339	18.690
Maximum	37.200	1823.824	26.503

The sample of the men's handball team consisted of a total of 12 subjects. This sample is subdivided according to the different playing positions: 2 wingers (16.7%), 3 center backs (25%), 4 wingers (33.3%), 1 pivot (8.3%) and 2 goalkeepers (16.7%). The values are shown in Table 2.

Table 2.

Average values by position in men's handball

Position	CMJ max(cm)	Power (w)	Relative power (w/kg)
Lateral	38.35	2646.65	26.87
Central	38.36	2201.93	26.85
End	50.26	2549.40	30.72
Pivot	40.05	2581.58	27.46
Goalkeeper	40.35	2708.51	27.64

The position with the highest jump height is the winger with an average of 50.26 cm and the position with the highest power is the goalkeeper with an average of 2708.51 W. The position with the lowest jump height in the CMJ test was the center back with an average of 38.36 cm and an average power of 2201.92 W for center backs.

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The sample of the women's handball team consisted of a total of N=15 (100%). This sample is subdivided according to the different playing positions: 5 wingers (33.33%), 2 center backs (13.33%), 4 wingers (26.67%), 2 pivots (13.33%) and 2 goalkeepers (13.33%). The values are shown in Table 3.

Table 3.

Average values by position in women's handball

Position	CMJ max(cm)	Power (w)	Relative power (w/kg)
Lateral	24.96	1452.79	22.01
Central	28.00	1264.62	22.99
End	31.20	1305.77	21.82
Pivot	22.35	1836.79	20.52
Goalkeeper	23.00	1187.84	14.94

The position with the highest height of the female handball team was the wingers with 31.2 cm and the highest average power was for the pivots with 1836.78 W. The position of the goalkeepers was the one with the lowest average jump with 23 cm, and the power had the lowest average value in the same position, goalkeepers.

The sample of the men's basketball team consists of a total of 11 athletes. This sample is subdivided according to the different playing positions into 3 point guards (27.27%), 2 shooting guards (18.18%), 2 forwards (18.18%), 2 power forwards (18.18%) and 2 centers (18.18%). The values are shown in Table 4.

Table 4.

Average values by position in men's basketball

Position	CMJ max(cm)	Power (w)	Relative power (w/kg)
Base	42.37	2219.19	28.21
Point guard	37.35	2309.52	26.55
Small Forward	47.65	2518.71	29.98
Wing-Power	41.20	2351.46	27.91
Center	32.75	2395.49	24.57

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Eaves was the playing position of the men's basketball team with the highest average jump and power obtained by the team. Being 47.65 cm and 2518.70 W respectively. On the contrary, we see that the position that obtained the lowest data in terms of jump height was that of the pivots with an average of 32.75 cm, compared to the point guards who had the lowest power in the test, 2219.19 W.

The sample of the women's basketball team consisted of 11 athletes. This sample is subdivided according to the different playing positions: 2 point guards (18.18%), 2 shooting guards (18.18%), 3 forwards (27.27%), 2 power forwards (18.18%) and 2 pivots (18.18%). The values are shown in Table 5.

Table 5.

Average values by position in women's basketball

Position	CMJ max(cm)	Power (w)	Relative power (w/kg)
Base	27,85	1307,64	22,94
Point guard	23,25	1223,60	21,00
Small Forward	30,10	1390,38	23,70
Wing-Power	25,75	1583,80	22,00
Center	22,35	1631,47	20,52

Finally, in women's basketball, it was observed that the forwards had the highest jump height, however, the pivots were the ones who stood out for their power in the result, being 30.1 cm and 1631.46 W respectively. On the contrary, the lowest jumping height were the pivots 22.35 cm and the shooting guards were the ones who obtained the lowest average power, 1223.6 W.

Discussion

The objectives of this research were (1) to perform a descriptive analysis to compare jump height and lower body power between basketball and handball players according to gender and (2) to identify the position of the player with the highest intradepartum power.

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In the present research shows an average jump height of 41.950 ± 7.616 cm handball is slightly higher than basketball 40.455 ± 6.179 cm contextualized in the male sport, as in the study of Pontaga and Zidens (2018), where this fact is also observed, obtaining that the jump height in handball is 47.6 ± 7.6 cm, while in basketball is slightly 47.4 ± 7.8 cm without presenting significant differences $p = 0.94$. In turn, these results also coincide with the study by Dal Monte et al. (1987), where no significant differences were found between the two sports, with an approximate average jump of 40 cm, very similar to the values obtained in this study. The similarity between these values may be due to the demands of the categories where the teams participate (McKay et al. (2021) that are directly related to a rhythm of play, which gives more intensity, causing in turn greater effect on performance in performance (Delextrat & Cohen, 2008; Khortabi et al., 2023). In the case of the present study and that of Dal Monte et al., (1987) are cataloged between levels 2 and 3, unlike that of Pontaga and Zidens (2018) where level 3 and 4, therefore it is observed that the jump height is greater.

On the other hand, the study of Pontaga and Zidens (2018) indicates that basketball players perform sprints of 3.70 ± 0.36 meters per second (m/s), greater than handball $3.63 \pm 0.0.24$ m/s, although no significant differences are shown between the two $p = 0.492$. In the present study it can be observed that basketball power 2346.176 ± 165.139 W is slightly lower than the results obtained from handball 2510.625 ± 283.166 W with which, in this case it is not possible to establish a direct relationship between sprinting and jumping capacity.

Regarding the female gender, the jumping height was lower than that of the male gender, these results coincide with what is generally established in the scientific literature due to the anthropometric and conditional differences between men and women (Mateluna-Núñez et al., 2022; León et al., 2023).

On the other hand, it is known that the female players of the first Spanish handball league have a jump height of 29 ± 4 cm (Ferragut et al., 2018) and also, specifically for female basketball players older than 19 years, the average is 29.0 ± 4.65 cm (Kellis et al., 1999). This fact coincides as well as the comparison with the male sex with which no major differences are appreciated in the results obtained in both sports (Monte et al.,

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1987; Pontaga and Zidens, 2018; Baljinder et al., 2014). Therefore, the data of this research reflect, on the one hand, that there are no large differences between the results obtained in both sports in terms of jump height, but on the other hand, there are slightly lower averages, being 25.33 ± 5.08 cm for women's handball and 26.25 ± 5.08 cm for women's basketball. Based on this, it can be seen that female basketball players in Cantabrian sport have a greater jump height.

Taking into account the Cantabrian context and that the women's handball team belongs to the División de honor category, higher than the handball team that plays in División de honor (3rd national league) in the level of performance of the players does not fit the classification framework (McKay et al., 2021) and other factors such as the type of training or the time of the season may come into play (Aguilar-Martínez, 2017).

Regarding playing positions Pehar et al., (2017) in their study indicate that professional basketball players from Bosnia and Herzegovina the position with the highest jump height are point guards, 46.44 ± 6.00 cm. In the case of handball, the best results are presented by players playing in the center position in Portuguese professional handball, 40.17 ± 5.71 cm (Massuca et al., 2015). However, the results obtained in this research are far from what these studies indicate, since the highest jump height in basketball was for forwards, 47.650 ± 0.919 cm in the male gender and in the female gender 30.100 ± 7.000 cm, this fact may be due to the differences between the anthropometric profiles of the judges (Pehar et al., 2017; Rösch et al., 2020; Ibáñez et al., 2023). In handball, in the male gender, the position with the highest jump height were the wingers (50.267 ± 9.701 cm) and in the center backs in the case of women (31.100 ± 4.384 cm), being the only team analyzed that follows the trend of other studies and that could also be the result of anthropometric profiles in this case homogeneous (Rösch et al., 2020; Ibáñez et al., 2023).

Conclusion

It is concluded that the parameters obtained from the results of the vertical jump in terms of flight height between basketball and handball are greater for men than for women, as established unanimously by the authors. In both the male and female

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genders, the comparison between both sports shows that results similar to those of other studies are obtained, so it cannot be affirmed that one sport has a greater jump height and power, however, the same does not occur taking into account the level of the athlete, since the highest parameters are shown in categories that require a higher level of demand, although there may be biases based on the time of the season.

On the other hand, it is observed that there is a differentiation between positions, obtaining higher values in terms of jump height for wingers in handball and forwards in basketball.

However, the positions with greater power are more heterogeneous, being able to affirm that goalkeepers in men's handball and pivots in women's handball are the ones that obtain the best results. As for women's basketball, the position with the highest power is the pivot and in men's basketball the forwards. It is also concluded that the results of this research in a sample of athletes of these sports disciplines in Cantabria does not conform to other studies of each sport and that the variability between the different anthropometric profiles can be a determining factor.

Finally, the results obtained in this research constitute important starting information for the teams of the Autonomous Community of Cantabria, providing more in-depth data on the performance of their athletes in lower body power by positions and comparing it with athletes from similar studies. This could facilitate the programming of more specific training for the improvement of lower body power according to position.

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