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Relationship between Body Composition and Physical Performance by Sex in Professional Basketball Players

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Abstract: This study aimed to identify the relationship between body composition (fat-free mass and body fat percentage) and physical performance (countermovement jump, CMJ; throwing ball; maximal isometric handgrip strength, MIHS dominant and non-dominant hands; 10-m and 20-m sprints with and without ball) in Chilean professional basketball players. Its secondary aim was to analyze if there were differences in body composition and physical performance according to sex. This was a cross-sectional study that analyzed 23 professional basketball players with a mean age of 24.0 ± 4.92 years, distributed among male professional basketball players (male professional BPs, n = 12) and female professional basketball players (female professional BPs, n = 14). The main results indicate the correlation presented significant relationships between fat-free mass with CMJ (r = 0.760; $p < 0.0001$; ES = 1.43), MIHS dominant hand (r = 0.783; $p < 0.0001$; ES = 1.50) and MIHS non-dominant hand (r = 0.805; $p < 0.0001$; ES = 1.85), throwing ball (r = 0.586; $p = 0.001$; ES = 0.56), 10 m sprint with ball (r = −0.510; $p = 0.007$; ES = 0.35), and 20 m sprint with ball (r = −0.143; $p = 0.046$; ES = 0.16). As did body fat percentage with CMJ (r = −0.647; $p = 0.000$; ES = 0.56), throwing the ball (r = −0.657; $p = 0.000$; ES = 0.58), MIHS dominant hand (r = −0.745; $p < 0.0001$; ES = 1.17), and MIHS non-dominant hand (r = −0.820; $p < 0.0001$; ES = 1.50). In conclusion, body composition is related to physical performance in professional basketball players. Meanwhile, male professional BPs had better body composition and physical performance than female professional BPs.

Keywords: team sports; athletic performance; professional practice; professional competence; athletes

1. Introduction

Basketball is a team sport that requires a wide range of physiological, mechanical, technical, and tactical demands [1,2]. Its temporal structure is characterized by being intermittent,

combining high-intensity actions (<6 s) and moderate-intensity actions (60 s) [3,4]. Basketball athletes constantly perform multidirectional actions such as accelerations, decelerations, direction changes, jumps, lateral displacements, and static efforts [5,6]. In this sense, basketball players require significant athletic development for good performance in their sporting actions [7].

On the other hand, the high physical demand of basketball movements generates a constant load on the players' bodies [8]. This load is given by the athlete's body weight [9,10]; thus, body composition can influence physical performance in basketball [11]. A favorable body composition profile is that athletes have lower body fat, given that it has been shown that the relative proportion of body fat is negatively associated with the execution of quick actions such as changes of direction, jumps, and movements [12]. Additionally, studies have shown that a higher relative proportion of body fat increases the risk of overuse injuries (e.g., patellar tendinopathy, rotator cuff tendinopathy) in basketball players [11,13]. Based on the above, it is relevant for players to regularly monitor their body fat percentage in order to optimize their physical performance and reduce the percentage of injuries. However, body composition and physical performance can vary depending on sex [11,14] and competitive level in basketball players [11].

In a meta-analysis conducted by Sansone, Makivic, Csapo, Hume, Martínez-Rodríguez, and Bauer [11] on basketball players of different levels, it was reported that male basketball players have a significantly lower body fat percentage ($p < 0.01$) compared to female basketball players. In the study of Fields et al. [15] on college league first-division basketball players, it was reported that males showed a significantly higher fat-free mass ($p < 0.05$) compared to females. In a study conducted by Sánchez-Díaz et al. [16] on young elite basketball players, it was reported that males presented a significantly greater jump height in countermovement jump (CMJ, $p < 0.001$) compared to females, as a better performance in 10 m sprints (10 m sprints, $p < 0.001$) and 20 m sprints (20 m sprints, $p < 0.001$). Similar to that reported by Philipp et al. [17] in college league first-division basketball players, males presented a significantly greater jump height in CMJ ($p = 0.02$) than females. Similarly, Barrera-Domínguez et al. [18] reported that males presented a significantly greater jump height in CMJ ($p < 0.001$) compared to females in semi-professional basketball players. In the study by Koley and Jarnail [19] in college league, male and female basketball players showed significant differences in lower body fat percentage ($p < 0.01$) and higher maximal isometric handgrip strength (MIHS) for dominant ($p < 0.01$) and non-dominant ($p < 0.01$) hands in favor of male regarding female.

Although it had been shown that body composition and physical performance differ according to sex in college and professional athletes [11,15–18], there is a relationship between these variables in basketball players [19–21]. In a study conducted by Ramos, Volossovitch, Ferreira, Teles, Fragoso, and Massuça [20] in elite adolescent basketball players, a significant correlation was reported between body fat percentage with 20 m sprint ($r = 0.23$, $p \leq 0.01$), CMJ ($r = -0.35$, $p \leq 0.001$), and fat-free mass with throwing ball ($r = 0.34$, $p \leq 0.001$) in male basketball players. While in female basketball players, significant correlations were reported between body fat percentage with CMJ ($r = -0.27$, $p \leq 0.01$) and fat-free mass with throwing ball ($r = 0.50$, $p \leq 0.001$). Similar to that reported by Čaušević, Čović, Abazović, Rani, Manolache, Ciocan, Zaharia, and Alexe [21] for semi-professional junior male basketball players, significant correlations were reported between body fat percentage with CMJ ($r = -0.49$, $p \leq 0.01$) and 20 m sprints ($r = 0.66$, $p \leq 0.01$) in 14-year-old players, CMJ ($r = -0.62$, $p \leq 0.01$) and 20 m sprints ($r = 0.56$, $p \leq 0.01$) in 15-year-old players, and CMJ ($r = -0.39$, $p \leq 0.01$) and 20 m sprints ($r = 0.53$, $p \leq 0.01$) in 16-year-old players. Similarly, Koley and Jarnail [19] in college league basketball players reported significant correlations between body fat percentage and MIHS for dominant ($r = -0.34$, $p < 0.01$) and non-dominant ($r = -0.35$, $p < 0.01$) hands.

There is evidence of differences in body composition and physical performance and the relationship between these variables in young and adult [15–18], collegiate, semi-professional, and elite basketball players [15–21]. So far, there is little evidence in profes-

sional basketball players according to sex [11,18]. In addition, Chile's internal competitive level is different from that of other countries in the region, making it interesting to investigate its participants' physical characteristics and performance [22]. These differences in the competitive level (semi-professional, professional, and elite) also impact sport performance, due to the inequalities in remunerations between the Chilean league and the rest of the American leagues. The Chilean league is the league with the lowest average salary in Latin America (3k–4k USD/month), compared to the National Basketball Association (NBA), which is the most important league worldwide in this discipline [23,24]. The influence of the remuneration of elite players belonging to the league has been reported, which can motivate players to work harder, score more points, and increase their physical performance, which defines a higher salary [24]. These differences in the competitive level also affect sports performance, due to the salary differences between the Chilean league and the rest of the leagues, being the league with the lowest average salary in Latin America (3k–4k/month), unlike the National Basketball Association (NBA), where the salary can motivate players to work harder, score more points, and increase their physical performance, which defines a higher salary [23]. Therefore, this study aimed to identify the relationship between body composition (fat-free mass and body fat percentage) and physical performance (CMJ, throwing ball, MIHS dominant and non-dominant hands, 10 m and 20 m sprints speed with and without ball) in Chilean professional basketball players. Secondarily, to analyze if there are differences in body composition and physical performance according to sex. It is hypothesized that a significant correlation exists between body composition and physical performance in professional basketball players [19–21]. Also, male professional basketball players (male professional BPs) had better body composition and physical performance than female professional basketball players (female professional BPs) [11,16–19].

2. Materials and Methods

2.1. Study Design

This study presents a cross-sectional, descriptive, and comparative correlational design. Professional basketball players from Osorno, Chile, were invited to participate in this study. They were distributed according to sex (male and female). Measurements of body composition (body fat percentage and fat-free mass) and physical performance (CMJ, throwing ball, MIHS dominant and non-dominant hands, and 10 m and 20 m sprint speed with and without ball) were performed. Body composition measurements were performed in the morning fasting in a laboratory under controlled conditions with a temperature between 21 °C and 24 °C. In contrast, physical performance measurements were performed in the morning in a gymnasium with a roofed wooden surface, where the players wore footwear appropriate to the context of the sport. Body composition and physical performance measurements were performed on different days. At the same time, the clothing was shorts and sleeveless shirts to facilitate the movement of the arms. They were held during the inaugural season in April of Chile's male and female national leagues.

2.2. Participants

Twenty-three basketball players would be the ideal number of participants, according to the sample size calculation [16]. With a large effect size (d = 0.40) and a power of 80% (β), an alpha level (α) of 0.05 was taken into consideration. Statistical power was computed using the G*Power program (version 3.1.9.6, Franz Faul, Universiät Kiel, Kiel, Germany). A total of 26 professional basketball players (mean age of 24.0 ± 4.92 years) were chosen, with male professional BPs (n = 12) and female professional BPs (n = 14) divided by sex. The following were the inclusion criteria: (i) the National Female's League and the Chilean National Basketball League were regarded as being home to professional basketball players; (ii) starting and backup players were also included in this category; and (iii) players whose sole occupation is basketball were included. The following were the criteria for exclusion: (i) basketball players, either amateur or professional; (ii) those undergoing pharmacological treatments that could impact body composition or physical performance; (iii) those taking

sports supplements designed to enhance physical performance; and (iv) those not receiving medical attention for injuries. Twenty-nine professional basketball players were initiated. Just two female professional BPs and one male professional BP were disqualified due to incomplete physical performance assessments.

All participants consented to the terms for processing and using the data by signing an informed consent form or an assent form, enabling their use for scientific research. The study protocol was reviewed and approved by the Scientific Ethics Committee of Universidad Autónoma de Chile (approval number: 126/18). The Helsinki Declaration's recommendations for human subject research were followed in the creation of the protocol.

2.3. Body Composition

Body weight (Scale-tronix, Chicago, IL, USA; accuracy to 0.1 kg) and bipedal height (Seca model 220, SECA, Hamburg, Germany; accuracy to 0.1 cm) were measured while fasting, and participants were asked to empty their bladder, not to use metal objects, and to wear light clothing and be barefoot when performing the measurement. To determine the body fat percentage and fat-free mass, tetrapolar bioimpedance (InBody 570®, Seoul, Republic of Korea) with eight tactile point electrodes was utilized. The International Society for the Advances in Kinanthropometry (ISAK) recommendations were followed for each measurement [25].

2.4. Countermovement Jump (CMJ)

The CMJ was administered in accordance with the recommendations made by Bosco et al. [26]. For the CMJ, professional basketball players utilized an Ergojump® Globus movable contact platform (ErgoTest, Codogne, Italy) to perform maximal effort jumps with their arms crossed over their iliac crests. During the flying phase, players executed full knee and ankle extensions, and landing and takeoff were standardized at the same time [27]. A high reliability of 0.98 was discovered for the CMJ data that was gathered. Three attempts were performed, with the best of the three attempts being recorded for analysis, with an intermediate recovery time of 120 s.

2.5. Throwing Ball

As previously advised, explosive muscle strength for the upper body was assessed using the ball-throwing test [28]. The test began with the participants sitting with their backs against the wall and a chest throw utilizing a ball (Molten BG 4000, FIBA approved, Japan). The highest velocity obtained in the two attempts (measured in km/h) was recorded. To measure this maximum speed, a radar gun (Speed Gun SR3600; Sports Radar®, Homosassa, FL, USA) was used with a pressure of 3%/1 mile per hour (MPH) or 1 kilometer per hour (km/h) [29]. The evaluator was positioned in front of the thrower at a distance of two meters, pointing towards the object separated by a mesh where the ball arrived [27]. It was discovered that the data gathered from throwing balls had a high reliability of 0.92. Two attempts were made, with a recovery time of 120 s recorded between attempts.

2.6. Maximal Isometric Handgrip Strength (MIHS)

The instrument utilized was a portable dynamometer (Patterson Medical, Sammons Preston Rolyan, Chicago, IL, USA). Allowing for the aforementioned considerations, the test was conducted while the subject was seated, with the spine aligned, the shoulder in a neutral position, the elbow flexed at a 90-degree angle to the side of the body, the forearm in a neutral position, and the wrist in a neutral posture [30]. The dynamometer was positioned to allow for a firm grasp on the instrument and sufficient closure of the metacarpal phalangeal and interphalangeal joints, with a preference for contact between the thumb and index finger's first phalanx, based on the size of the hand [27]. The data gathered by MIHS was determined to have a high reliability of 0.98. Each individual participated in three attempts on each hand, separated by a 120 s recovery, recording the best of the three attempts for analysis.

2.7. Running Sprint Speed

A Brow-er® timing system (Salt Lake City, UT, USA) was utilized to compute sprint time with single-beam timing gates to an accuracy of 0.01 s. Professional basketball players (female professional BPs and male professional BPs) first formed their preferred toe-off line by lining up behind it. The players initiated the test by turning on the timing automatically and starting the sprint. Timing gates were used during the 10 m and 20 m sprints, both with and without a ball, and at the start line (0.3 m in front of the competitor). They were positioned at hip height, or roughly 0.7 m above the floor. Instead of inadvertently activating a limb, trunk movement might be captured using this method. The three sprint attempts were separated by a one-minute rest, after which the best result was noted [27,31]. It was discovered that the peak velocity data from the 10 m and 20 m sprints had a high reliability of 0.94.

2.8. Statistical Analysis

Mean and standard deviation (SD; ±) were used to present descriptive statistics. The Shapiro–Wilk test was used to determine the normality of the data, while Levene's test was used to determine the homogeneity of variance. A normal distribution was observed in the data; therefore, to compare male professional BPs and female professional BPs in terms of body composition and physical performance, Student's *t*-test for independent samples was used. To determine the correlation between body composition and physical performance, Pearson's r for bivariate samples was used, considering the correlation as infimum (0.00–0.20), low (0.20–0.40), moderate (0.40–0.60), large (0.60–0.80), and very large (0.80–1.00) [32]. The effect size (ES) was calculated with Cohen's d [33], considering a small (≥0.2), moderate (≥0.5), or large (≥0.8) effect. The α level was set at $p < 0.05$ for statistical significance. Data were analyzed with SPSS 25.0 statistical software (SPSS 25.0 for Windows, SPSS Inc., Chicago, IL, USA).

3. Results

Among the main results for body weight are the following: significant differences were found in favor of male professional BPs (F = 0.530; $p = 0.020$) and height (F = 0.001; $p = 0.001$) compared to female professional BPs. However, no significant differences were found for body mass index. Significant differences were reported in body composition regarding male professional BPs in body fat percentage (F = 0.052; $p = 0.000$) and fat-free mass (F = 12.864; $p = 0.000$) compared to female professional BPs.

In physical performance, significant differences were reported in CMJ in favor of male professional BPs (F = 19.138; $p = 0.000$), ball throwing (F = 0.903; $p = 0.000$), and MIHS dominant hand (F = 1.548; $p = 0.000$) and MIHS non-dominant hand (F = 0.249; $p = 0.000$) compared to female professional BPs. However, no significant differences were reported in 10 m sprint (F = 3.822; $p = 0.371$), 10 m ball sprint (F = 2.365; $p = 0.142$), 20 m sprint (F = 0.753; $p = 0.915$), and 20 m ball sprint (F = 1.081; $p = 0.301$) between male professional BPs and female professional BPs. These results are presented as mean and standard deviation in Table 1.

Figure 1A,B show the correlations between fat-free mass and physical performance in professional basketball players. A significant positive and large correlation was found between fat-free mass with CMJ (r = 0.760; $p < 0.0001$; ES = 1.43, *large effect*), MIHS dominant hand (r = 0.783; $p < 0.0001$; ES = 1.50, *large effect*), and MIHS non-dominant hand (r = 0.805; $p < 0.0001$; ES = 1.85, *large effect*), in addition to significant positive and moderate correlation with throwing ball (r = 0.586; $p = 0.001$; ES = 0.56, *moderate effect*), 10 m ball sprint (r = −0.510; $p = 0.007$; ES = 0.35, *small effect*), and weak correlation 20 m ball sprint (r = −0.143; $p = 0.046$; ES = 0.16, *insignificant effect*). In contrast, no significant correlations were observed between fat-free mass and 10 m sprint (r = −0.227; $p = 0.263$; ES = 0.04, *insignificant effect*) and 20 m sprint (r = −0.349; $p = 0.079$; ES = 0.01, *insignificant effect*).

Table 1. Body composition and physical performance of professional basketball players according to sex.

	Male Professional BPs (n = 12)	Female Professional BPs (n = 14)	p Value
Age (years)	23.1 ± 4.43	24.9 ± 5.41	0.354
Body weight (kg)	86.1 ± 13.7	75.0 ± 10.5	**0.020**
Height (cm)	187.0 ± 9.44	175.4 ± 8.97	**0.001**
BMI (kg/m^2)	24.3 ± 2.54	24.5 ± 2.53	**0.000**
Body fat percentage (%)	12.9 ± 4.9	25.8 ± 5.99	**0.000**
Fat-free mass (kg)	43.1 ± 6.52	34.9 ± 3.25	**0.000**
CMJ (cm)	45.2 ± 7.59	27.8 ± 3.55	**0.000**
Throwing ball (km/h)	40.5 ± 3.09	34.2 ± 3.16	**0.000**
MIHS dominant hand (kg)	49.3 ± 7.75	32.4 ± 4.37	**0.000**
MIHS non-dominant hand (kg)	48.5 ± 6.71	30.9 ± 4.57	**0.000**
10 m sprint (s)	2.16 ± 7.75	2.53 ± 5.17	0.371
10 m ball sprint (s)	2.26 ± 6.88	2.35 ± 11.2	0.142
20 m sprint (s)	3.53 ± 5.18	3.70 ± 1.21	0.915
20 m ball sprint (s)	3.81 ± 15.4	3.88 ± 20.0	0.301

Male Professional BPs: male professional basketball players. Female Professional BPs: female professional basketball players. BMI: body mass index. CMJ: countermovement jump. MIHS: maximal isometric handgrip strength.

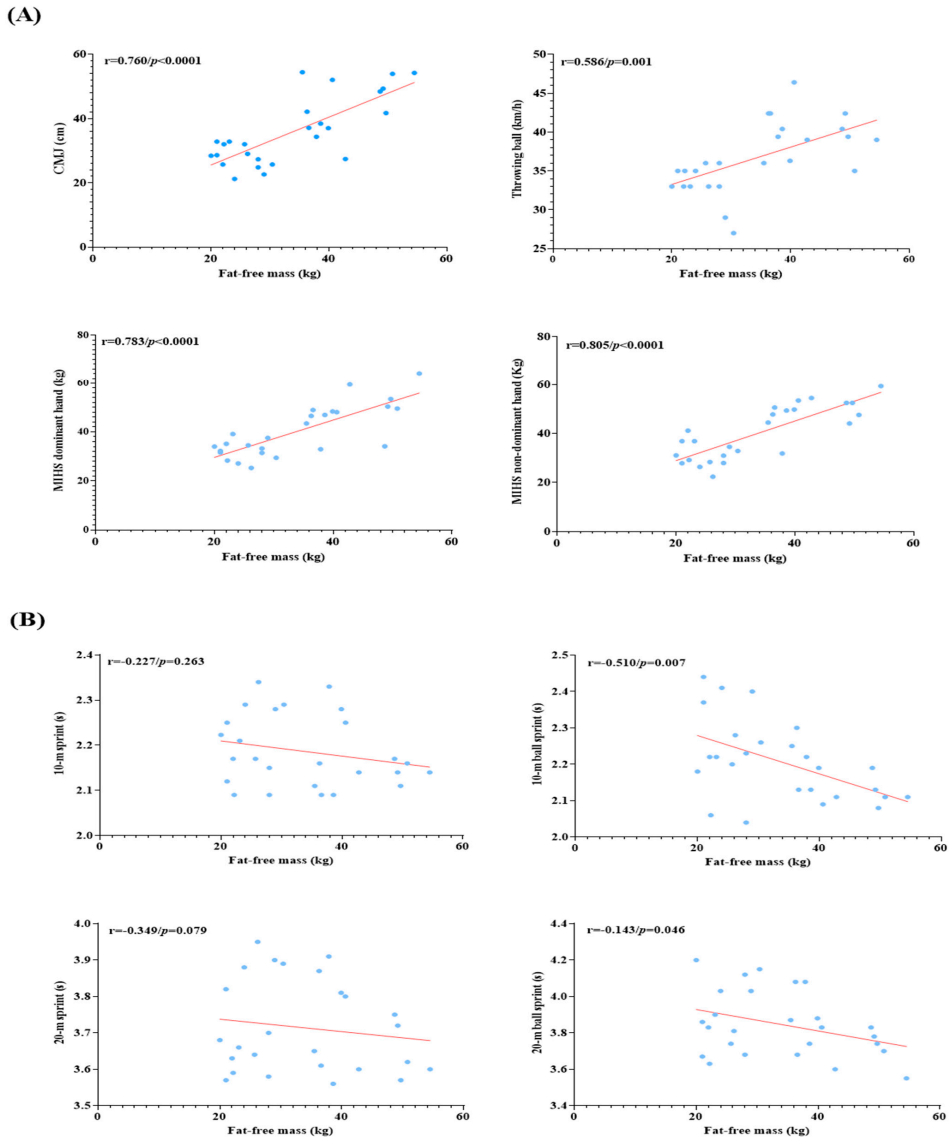


Figure 1. Correlation between fat-free mass and physical performance in professional basketball players. (**A**) Fat-free mass regarding muscle strength and power; (**B**) fat-free mass regarding speed with and without ball. CMJ: countermovement jump. MIHS: maximal isometric handgrip strength.

Figure 2A,B show the correlations between body fat percentage and physical performance in professional basketball players. A significant negative and large correlation was reported with CMJ (r = −0.647; p = 0.000; ES = 0.56, *moderate effect*), throwing a ball (r = −0.657; p = 0.000; ES = 0.58, *moderate effect*), MIHS dominant hand (r = −0.745; $p < 0.0001$; ES = 1.17, *large effect*), and MIHS non-dominant hand (r = −0.820; $p < 0.0001$; ES = 1.50, *large effect*). On the contrary, a no significant correlation in 10 m sprint (r = 0.261; p = 0.197; ES = 0.03, *insignificant effect*), 10 m with ball sprint (r = 0.214; p = 0.292; ES = 0.02, *insignificant effect*), 20 m sprint (r = 0.240; p = 0.235; ES = 0.03, *insignificant effect*), and 20 m with ball sprint (r = 0.204; p = 0.317; ES = 0.03, *insignificant effect*) with fat-free mass was reported.

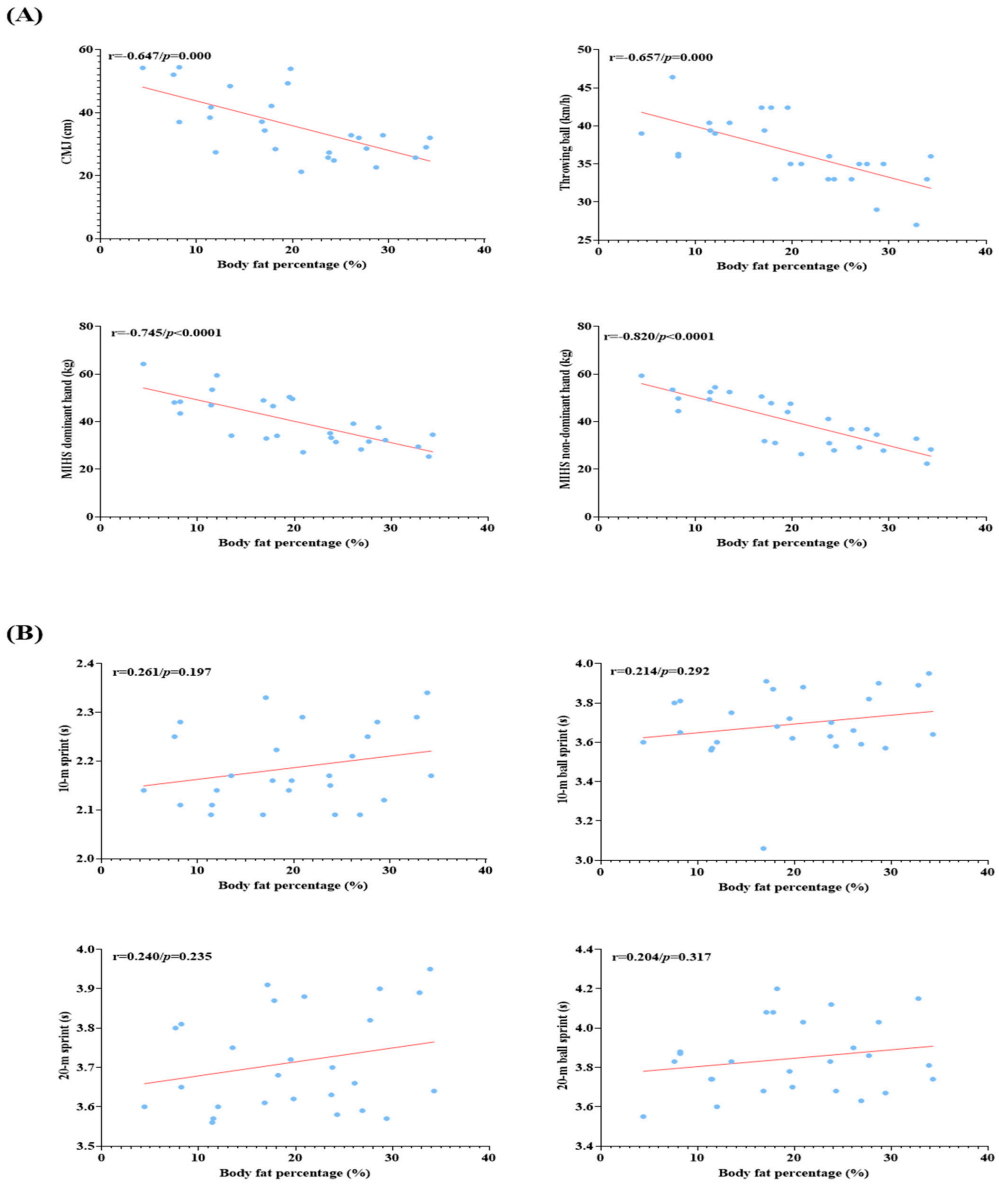


Figure 2. Correlation between body fat percentage and physical performance in professional basketball players. (**A**) Body fat percentage regarding muscle strength and power. (**B**) Body fat percentage regarding speed with and without ball. CMJ: countermovement jump. MIHS: maximal isometric handgrip strength.

4. Discussion

This study aimed to identify the relationship between body composition and physical performance in Chilean professional basketball players, with a secondary aim of analyzing

if there are differences in body composition and physical performance according to sex. The male professional BPs presented a significantly lower body fat percentage and a higher fat-free mass with significantly better performance in CMJ, throwing a ball, and MIHS dominant and non-dominant hands than female professional BPs.

Our results show that male professional BPs had a lower body fat percentage than female professional BPs. Similar results to those reported in the meta-analysis conducted by Sansone, Makivic, Csapo, Hume, Martínez-Rodríguez, and Bauer [11] reported that male basketball players had a lower body fat percentage ($p < 0.001$) compared to female basketball players. Similarly, Toro-Román et al. [34] in semi-professional soccer players in the fourth division of Spain showed a lower body fat percentage ($p < 0.001$) in male soccer players compared to female soccer players. In this regard, the differences in the body fat percentage in the sexes can be attributed mainly to the action of sexual steroid hormones, which drive dimorphisms from pubertal development that continue throughout life [34,35]. Various studies have reported that the variables linked to adipose tissue are the most dimorphic [35–37]; this reflects the adaptive nature of adipose tissue in the female sex [35]. In females, the greater accumulation of fatty tissue is related to the biological needs of some stages of life (i.e., menarche, pregnancy, and lactation) [38]. In this sense, the higher body fat percentage in female professional BPs compared to male professional BPs in our study can be explained mainly by evolutionary factors and hormonal differences (i.e., higher estrogen levels) [39].

Another reported result was that male professional BPs had a higher fat-free mass than female professional BPs. Similar to that reported by Fields, Merrigan, White, and Jones [15] in college league division I basketball players, males showed a higher fat-free mass ($p < 0.05$) compared to females. Skeletal muscle mass represents approximately half of the fat-free mass in humans [40]. In this regard, males have greater muscle size, larger bones, and a lower body fat percentage in the extremities, unlike females with a more peripheral fat distribution [34]. Furthermore, males have greater muscle mass than females in absolute terms and concerning body mass, with an essential difference in the upper body [41]. Specifically, in our study, male professional BPs had a greater fat-free mass than female professional BPs, which can be explained by the superior production of testosterone and, on the other hand, the more significant body fat percentage associated with higher levels of estrogen in females [42].

In physical performance, it was reported in CMJ that male professional BPs had a superior jump height than female professional BPs. Similar results to those reported by Sánchez-Díaz, Yanci, Raya-González, Scanlan, and Castillo [16] in elite junior basketball players, the male presented a better jump height in CMJ ($p < 0.001$) compared to the female. Similarly, in college basketball players, Philipp, Cabarkapa, Nijem, Blackburn, and Fry [17], male basketball players presented a higher jump height in CMJ ($p = 0.02$) than female basketball players. These differences can be explained by the morphological characteristics of the muscle between males and females (i.e., muscle thickness, pennation angle, and fascicle length) that favor males to generate greater muscle strength [43–45]. Furthermore, it had been reported that the muscle area occupied by fast fibers is superior in males than in females [46]. The above may lead to females having better relative concentric vertical strength and a lower rate of development of eccentric strength for jumping [34,47].

The present study also reported a significant correlation between body fat percentage and fat-free mass with CMJ. These results are similar to those reported by Čaušević, Čović, Abazović, Rani, Manolache, Ciocan, Zaharia, and Alexe [21] in semi-professional basketball players, presenting significant and negative correlations in body fat percentage with CMJ in 14-year-old players ($r = -0.49$; $p \leq 0.01$), 15-year-old players ($r = -0.62$; $p \leq 0.01$), and 16-year-old players ($r = -0.39$; $p \leq 0.01$). The high demands on the motor actions of basketball (i.e., jumping, sprinting, and changes of direction) impose a considerable physical load on the players' bodies [9,10]. Therefore, a body composition profile with less fat mass may benefit basketball players [11]. In this sense, it has been reported that the relative proportion of body fat is negatively associated with executing explosive actions

such as changes of direction and vertical jumps [11,12,48]. Gil et al. [49] have reported that a high level of body fat percentage acts as extra body mass in motor actions, where the body mass must be lifted against gravity, which can considerably decrease the player's performance. Specifically, Gil, Gil, Ruiz, Irazusta, and Irazusta [49] reported that body fat determines the amount of biomechanical inertia that the athlete must overcome when accelerating and changing direction, so there is a negative association between a high body fat percentage and explosive actions.

Another result reported in the present study was that the male professional BPs had a higher throwing ball than the female professional BPs. Similar results to those reported by Wagner et al. [50] in elite handball players, where male players presented a higher throwing ball ($p < 0.05$) compared to female players. Similarly, Serrien, Clijsen, Blondeel, Goossens, and Baeyens [8] in semi-professional handball players reported that males presented a higher throwing ball ($p < 0.001$) compared to females. These findings, similar to the better performance in explosive strength of the lower body, can be explained by the morphological differences of the muscle between males and females (i.e., muscle thickness, higher percentage of fast fibers, pennation angle, fascicle length) [43,44]. On the other hand, body characteristics (i.e., height, body weight, and fat-free mass) play a key role in our findings [51]. The study of van de Tillaar and Etterna [52] reported that males throw faster and produce more force due to their greater height than females. When height, body weight, and fat-free mass were compensated for, this throwing velocity difference was smaller between males and females [53]. Based on the above, the male professional BPs in our study had a height of 187.0 $\pm$ 9.44 cm and a body weight of 86.1 $\pm$ 13.7 kg, compared to the female professional BPs, who had a height of 175.4 $\pm$ 8.97 cm and a body weight of 75.0 $\pm$ 10.5 kg. The above reinforces the idea that the difference in the ball-throwing test between males and females may be based mainly on differences in height and body weight [52,53].

In the present study, there was a significant correlation between body fat percentage (negative correlation) and fat-free mass (positive correlation) with the ability to throw a ball. Similarly, Ramos, Volossovitch, Ferreira, Teles, Fragoso, and Massuça [20] in elite basketball players reported significant and positive correlations between fat-free mass and throwing a ball in males (r = 0.34; $p < 0.01$) and females (r = 0.50; $p < 0.01$). Similarly, Hermassi et al. [53] in professional handball players reported significant and negative correlations between body fat percentage and throwing ball (r = -0.23; $p < 0.05$). Our findings can be attributed to the fact that the male professional BPs in our study had a greater fat-free mass compared to female professional BPs (43.1 $\pm$ 6.52% vs. 34.9 $\pm$ 3.25%), allowing them to throw faster due to the greater muscle mass percentage (larger area of cross-section of the muscle) [54], which can translate into a better force applied to an implement [55]. In addition, the higher body fat percentage in female professional BPs (25.8 $\pm$ 5.99%) versus male professional BPs (12.9 $\pm$ 4.98%), as mentioned above, can act as extra body mass in motor actions where body segments must be raised against gravity, generating a decrease in the speed of the task executed [49].

On the other hand, in the present study it was that male professional BPs had a higher MIHS dominant and non-dominant hand than female professional BPs. Similar to the results reported by Koley and Jarnail [19] in college basketball players, males have a higher MIHS dominant hand ($p < 0.01$) and MIHS non-dominant hand ($p < 0.01$) compared to females. Similarly, Khanna and Koley [56] in college league volleyball players reported that male players had a higher MIHS dominant hand ($p < 0.001$) and MIHS non-dominant hand ($p < 0.001$) compared to female players. Also, Koley and Jarnail [19] in college league basketball players reported significant and negative correlations between body fat percentage with MIHS dominant hand (r = -0.34; $p \leq 0.001$) and MIHS non-dominant hand (r = -0.35; $p \leq 0.001$). As discussed in previous paragraphs, greater muscle mass, height, and body weight can favor muscular strength in male athletes compared to female athletes [49]. In addition, hormonal factors such as different testosterone levels between sexes affect muscle strength [57]. For example, it had been reported that when testosterone

levels increase in males, an increase in MIHS is found [57,58]. In addition, Khanna and Koley [56] have reported that hand dimensions (hand length, hand width, second digit length, and fourth digit length) affect MIHS. Taking this into consideration, hand size may also explain differences in MIHS between sexes [59], although this was not assessed in our study.

However, in the 10 m and 20 m sprints with and without a ball, no significant differences were reported between male professional BPs and female professional BPs. On the contrary, Sánchez-Díaz, Yanci, Raya-González, Scanlan, and Castillo [16] reported in male elite basketball players a better performance in 10 m sprint ($p < 0.001$) and 20 m sprint ($p < 0.001$) in comparison to females. Our study reported no significant correlations between body composition with 10 m sprints and 20 m sprints with and without a ball. On the contrary, Čaušević, Čović, Abazović, Rani, Manolache, Ciocan, Zaharia, and Alexe [21] in semi-professional basketball players reported significant and positive correlations between body fat percentage with 20 m sprints in 14-year-old players (r = 0.66; $p < 0.01$), in 15-year-old players (r = 0.56; $p < 0.01$), and in 16-year-old players (r = 0.53; $p < 0.01$). Following the trend of our findings and the current study, it would have been expected that males would perform better in the 10 m sprint and 20 m sprint tests with and without the ball than females; however, this did not occur; this could be due to differences in body weight between sexes. In this sense, it had been reported that a greater body weight acts as an extra load on motor actions in team sports [49]. If the body weight is superior, the biomechanical inertia that the athlete must overcome to accelerate during sprints is greater [49]. Therefore, if body weight had been similar between the sexes, there would probably have been significant differences in favor of male athletes, as reported in the other variables of our study. Female professional BPs were more efficient in these tests since their body composition and general physical performance were worse than male professional BPs, but there were no differences in the specific test.

4.1. Limitations and Strengths

The limitations of the study are the following: (i) not making a correlation by sex, which was not possible due to the low number in the sample; (ii) not comparing body composition and physical performance according to playing position by sex, where previous studies [60,61] have reported that there are differences in both body composition as well as physical performance according to playing position in different sports; and (iii) not controlling the hydration status and nutritional aspects that may have influenced body composition in professional basketball players. Among the strengths we find the following: (i) differentiating body composition and physical performance by sex in basketball players at a professional level, which can help in making decisions to program various training, maximizing performance; (ii) performing all measurements under the same conditions for both groups; (iii) having carried out the study on Chilean professional basketball players, due to the small number of studies related to the topic.

4.2. Practical Applications

Based on our findings, we can suggest some recommendations for coaches and coaching staff based on sex in basketball players. For example, female players reported a higher body fat percentage than males due to biological and evolutionary factors. As discussed above, a higher body fat percentage can be detrimental to performance in explosive actions (running, jumping, throwing, and changes in direction), so we suggest incorporating high-intensity interval training to reduce the body fat percentage in female athletes while improving their cardiovascular endurance [62]. The above and the inclusion of a nutritional plan can optimize sports performance in female players. In this regard, female players also presented a lower free-fat mass compared to their male peers, although this can be explained mainly by hormonal differences (testosterone production) and muscle morphological differences (e.g., muscle thickness, a greater percentage of fast fibers, angle of pennation, length of the fascicle), we recommend that female players in periods out of

competition, perform resistance training oriented towards hypertrophy together with a nutritional plan that provides a greater intake of proteins, to increase their muscle mass and, through mechanical and structural factors of the muscle, their levels of muscular strength in order to improve the performance of their sporting actions in periods of competition [63,64]. As found in the present study, the fat-free mass and body fat percentage were related to a higher speed in passing; this is important because physical performance and body composition are essential to maintaining the passing performance during a basketball game, since this action is a determining factor in the game, as well as jumping [65–67]. However, future studies could analyze how body composition is related to other variables that are performed during the basketball game, such as agility actions with and without the ball, physiological actions that can influence performance such as body composition, psychological factors, and other variables in jumping, such as take-off speed and flight time, that can be determinants in the game.

5. Conclusions

Male professional BPs presented a significantly lower body fat percentage with a significantly higher fat-free mass and physical performance in CMJ, ball throwing, and MIHS dominant and non-dominant hands compared to female professional BPs. To find a significant correlation between body composition and physical performance in professional basketball players, which allows better optimization of the training by considering the importance of body composition in the physical performance of both males and females.

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