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Original Article

Vertical jump and handgrip strength in basketball athletes by playing position and performance

GLEDSON T. DE A. OLIVEIRA[1], PETRUS GANTOIS[1], HELOIANA K. C. FARO[1], PAULO H. D. DO NASCIMENTO[1], PEDRO P. PAES[2], LEONARDO DE S. FORTES[2], GILMÁRIO R. BATISTA[3]
[1] Physical Education Department, Federal University of Rio Grande do Norte, Natal, Rio Grande do Norte, BRAZIL
[2] Physical Education Department, Federal University of Pernambuco, Recife, Pernambuco, BRAZIL
[3] Physical Education Department, Federal University of Paraiba, João Pessoa, Paraíba, BRAZIL

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Abstract:
This article compare Vertical Jump (VJ) and Handgrip Strength (HS) in basketball athletes by playing position and performance. The sample was composed of 183 male athletes. To evaluate the strength of the upper limbs, the HS isometric force test was used, while for the lower limbs the VJ countermovement test. In addition, it was analyzed maximum reach (MR), as well as was analyzed relative strength. It was observed that the centers displayed the lowest VJ score ($p = .029$). Regarding MR, centers displayed the highest score ($p < .001$). Regarding dominant HS, the guards displayed the lowest scores ($p = .005$) as well as non dominant HS ($p = .023$). It was found that G4 presented higher VJ ($p < .001$), as well as MR ($p < .001$). No difference was found regarding dominant and non dominant absolute HS, as well as relative scores ($p > .05$). It was found higher VJ performance in G4 athletes in every playing position (Guards: $p = .042$, Forwards: $p = .005$ and Centers: $p = .032$) as well as in MR (Guards: $p = .002$, Forwards: $p = .002$ and Centers: $p = .002$). No difference was found regarding dominant and non dominant HS and relative HS of dominant and non dominant hand between G4 and Z4 in any playing position ($p > .05$). In this sense, it is possible to conclude that different playing positions demand specific physical profile and motor skills, probably due to the difference in technical and tactical requirements that are assigned to each playing position.
Key words: athletic performance; muscle strength; body composition; motor skills.

Introduction

Basketball is composed of intermittent actions, which is characterized by requiring high technical and tactical demands intrinsically dependent on explosive strength and intercalated with short periods of recuperation at low intensity (Abdelkrim, Chaouachi, Chamari, Chtara, & Castagna, 2010). During the game, the players are frequently submitted to movements the requires vertical jump (VJ) (Abdelkrim, Fazaa, & Ati, 2007; McInnes, Carlson, Jones, & McKenna, 1995), characterizing VJ as an essential ability to achieve great performance at basketball (Rodriguez-Rosell, Mora-Custodio, Franco-márquez, Yañez-García, & González-badillo, 2016). The player's jump height is responsible for a higher number of successful shots, blocks, and rebounds (Erčulj, Blas, & Bračič, 2010). Additionally, studies indicate that there is a positive relationship between VJ performance and agility, sprint and maximum strength tests (Alemdaroğlu, 2012; Shalfawi, Sabbah, Kailani, Tønnessen, & Enoksen, 2011; Ziv & Lidor, 2010), and also, reporting that body fat percentage is capable to affect VJ performance, showing a negative relationship between them (Ribeiro, Mota, Sampaio-Jorge, Morales, & Leite, 2015).

In addition to VJ, basketball presents constant movements of driving, possession, and shots that require the use of both hands. In this sense, the estimative of handgrip strength (HS) is extremely important, for being a variable that expresses control maximization and athletic performance (Visnapuu & Jürimäe, 2007). As HS is highly influenced by body composition and technical abilities, this increases the importance of investigating these variables (Apostolidis & Emmanouil, 2015).

Another important factor of player's performance in basketball is their playing position, during technical defensive and offensive actions, each technical demand requires specific motor abilities and body profiles (Nikolaidis et al., 2015; Ostojic, Mazic, & Dikic, 2006).

Although it has been found differences in VJ in basketball athletes by player positioning (Abdelkrim et al., 2010; Ziv & Lidor, 2010), to the best of our knowledge, there are no investigations of HS in basketball players regarding basketball players according to their playing position. It is also observed the necessity to assess

Corresponding Author GLEDSON T. DE A. OLIVEIRA, E-mail: gledsontavares12@gmail.com

this variable in order to establish its importance to predict basketball performance and how it can be relevant for each playing position.

In this sense, the present study aims to compare VJ and HS of basketball athletes by playing position and performance. We hypothesize that differences will be found between playing position in VJ and HS and the athletes of higher ranked teams will display higher VJ and HS scores than the last placed teams.

Materials and Methods

Study Design

This study has a descriptive with a cross sectional design. The data collection was performed at the final period of the pre-season of the State Championship of Basketball, one month before the season commencement. The study was also approved by the State Federation of Basketball. In the first visit, the players were introduced to the research question and objectives through the reading and further signature of the informed consent. Then, it was performed the anthropometric measurements of the athletes and we performed a familiarization of the VJ and HS test. After a minimum interval of 24 hours, we conducted a second visit, where the athletes performed the VJ and HS test. During the data collection, the athletes were instructed to avoid vigorous physical activity, alcohol ingestion and have eaten a balanced meal in a period of 3 hours before the visit.

For data analyses, the athletes were distributed and compared according to their playing position (guard, forward, center) and according to the team rank (G4 = 4 best ranked teams; Z4 = 4 worse ranked athletes). This rank was assessed at the end of the competition.

Participants

Our participants were 204 four male athletes from 17 teams competing at the state championship of basketball, the inclusion criteria for this study was to have a period of active participation in basketball superior to 1 year. From these, 21 athletes were removed from the study for personal reasons or did not attend to the inclusion criteria. We had 89.7% (n=183) of participation. The mean age of the sample was 26.4 ± 9.3 years. The sampling procedure was intentional in a non-probabilistic way. The present study was approved by the local University ethics committee (process 178/2010) and followed the resolution 196/96 of the national health council involving research with humans. In addition, we respected the ethic principles stated in the Helsinki declaration. All participants were asked to read and sign the informed consent.

Anthropometrics

In our study, we measured body mass with a portable weight scale (Filizola® 110, São Paulo, Brazil) with accuracy of 0.1kg and maximal capacity of 150kg, the height was measured with a portable stadiometer (Sanny ES2020®, São Bernardo do Campo, Brazil) with accuracy of 0.1cm and, to measure body fat, we used calculus of body density estimated by the sum of four sites of skinfold (biceps, triceps, subscapular and suprailiac) (Durnin & Womersley, 1974), trough the measurement of the adipometer Cescorf with accuracy of 0.1mm. We, then, used the Siri equation (Siri, 1961), to measure the percentage of body fat. These measures were conducted by an experienced researcher. The test-retest coefficients for all measures were above 0.95 and the technical error measurement inferior to 5%. All measures followed the pattern adopted by the International Society for Advancement of Kinanthropometry – ISAK (Marfell-Jones, Stewart, & Ridder, 2012).

Vertical Jump (VJ)

We used counter-movement jump without arm swing to assess VJ performance. The movement was performed over a contact mat (Hidrofit Ltda), connected to the software Multisprint (Hidrofit Ltda). The protocol followed the Komi's recommendation (Komi & Bosco, 1978), where the athletes begin in orthostatic position, and keeping the hands on waist during the whole test flex and extend the hips, knees and ankle in an explosive movement. As the equipment calculate the height of the jump based on the interval of time between two contacts, the athletes were instructed to initially land with straight legs and on the same point (avoid horizontal movement). To minimize measurement errors, the athlete performed three attempts with an interval of one minute between tests, for our analyses we considered the best test. In addition, it was analyzed maximum reach (MR) (sum between jump height and maximum vertical reach with arms).

Handgrip Strength (HS)

To assess HS, we used a handgrip dynamometer (Jamar®). The athlete was instructed to stay seated with shoulder adducted, elbow flexed at 90º and hand at a neutral position. The athlete performed three attempts of 5 seconds of maximal contraction with 3 minutes between each attempt, for our analyses we considered the peak torque (kg) of the best test. The test was performed with the athletes' dominant and non dominant hand. In addition, it was analyzed relative strength (peak torque divided by body weight).

Statistical Analysis

The normality of the data distribution was assessed with Kolmogorov-Smirnov test of normality; the anthropometric values were normally distributed but the physical ones were not. The data was reported as median and interquartile interval. To compare the anthropometric variables between playing position, we used analyses of variance (ANOVA – one way) and for team rank, we used a t test for independent samples. To analyze possible differences in VJ and HS, it was performed a Kruskal-Wallis test to compare athletes by playing position and a Mann-Whitney test for team rank. All the analyses were performed with the Statistical Package for the Social Sciences – SPSS version 20.0. We adopted a significance level of $p < .05$.

Results

The comparison of the anthropometric variables and physical tests are described in table I. The centers presented higher body mass and height than the other groups ($ps < .001$), and presented higher fat percentage than forwards ($p < .001$). The guards had lower height than forward ($p < .001$). Regarding, the centers displayed the lowest VJ score ($H(2) = 7.065$; $p = .029$). Regarding MR, centers displayed the highest score ($H(2) = 45.315$; $p < .001$). Regarding dominant HS, the guards displayed the lowest scores ($H(2)= 10.417$; $p = .005$) as well as non dominant HS ($H(2)= 7.513$; $p = .023$). Further post hocs are shown in table I.

Table I. Comparison of the anthropometric variables and physical tests.

	GUARDS (n= 48)	**FORWARDS** (n= 79)	**CENTERS** (n= 56)
Body Mass (kg)	77.2 ± 18.05[b]	82.9 ± 19.10[c]	98.6 ± 22.33
Height (cm)	175.0 ± 8.50[ab]	183.0 ± 10.00[c]	193.0 ± 7.25
Body Fat (%)	17.8 ± 9.15	16.7 ± 7.09[c]	19.8 ± 6.60
Vertical Jump (cm)	43.0 ± 12.85[b]	44.9 ± 15.30[c]	39,15 ± 12,38
Maximum Reach (cm)	269.0 ± 20.70[ab]	282.0 ± 22.00[c]	294.0 ± 19.20
Dominant Handgrip Strength (kg)	41.0 ± 10.00	46.3 ± 10.83[a]	46.8 ± 13.75[b]
Non-Dominant Handgrip Strength (kg)	38.3 ± 9.67	43.3 ± 11.17[a]	40.7 ± 9.98[b]
Relative Dominant Handgrip Strength (kg/kg)	0.5 ± 0.12[b]	0.6 ± 0.17[c]	0.5 ± 0.15
Relative Non-Dominant Handgrip Strength (kg/kg)	0.5 ± 0.11[b]	0.5 ± 0.14[c]	0.4 ± 0.17

Significant Difference (p<0.05): [a]Guards vs. Forwards; [b]Guards vs. Centers; [c]Forwards vs. Centers.

The comparison of VJ, MR and absolute, and relative HS between the team rank (G4 and Z4) is presented in figure I. It was found that G4 presented higher VJ ($U = 468$; $p < .001$), as well as MR ($U = 316$; $p < .001$). No difference was found regarding dominant and non dominant absolute HS ($U = 926$; $p = .726$ and $U = 874$; $p = .433$). As well as relative scores ($U = 910$; $p = .628$ and $U = 960$; $p = .947$).

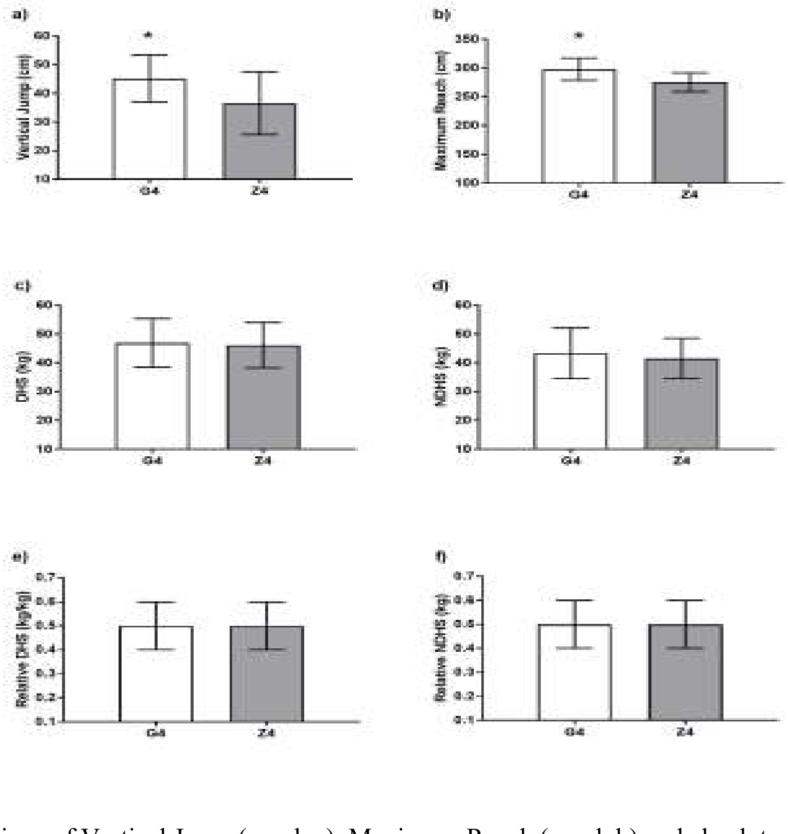

Fig. 1. Comparison of Vertical Jump (graph a), Maximum Reach (graph b) and absolute (graph c and d), and relative (graph e and f) Handgrip Strength between the team rank G4 and Z4. DHS - Dominant Handgrip Strength, NDHS - Non Dominant Handgrip Strength.

The comparison of VJ and HS between athletes of G4 and Z4 by playing position is presented in figure 2. It was found higher VJ performance in G4 athletes in every playing position (Guards: U = 33; p = .042, Forwards: U = 60,5; p = .005 and Centers: U = 48; p = .032) as well as in MR (Guards: U = 15; p = .002, Forwards: U = 51,5; p = .002 and Centers: U = 28; p = .002). No difference was found regarding dominant (Guards: U = 46; p = .133, Forwards: U = 136,5; p = .903 and Centers: U = 103; p = .832) and non dominant (Guards: U = 43; p = .094, Forwards: U = 127,5; p = .662 and Centers: U = 104; p = .866) HS and relative HS of dominant (Guards: U = 60; p = .488, Forwards: U = 138; p = .944 and Centers: U = 83; p = .290) and non dominant hand (Guards: U = 53; p = .273, Forwards: U = 130; p = .726 and Centers: U = 83; p = .290) between G4 and Z4 in any playing position.

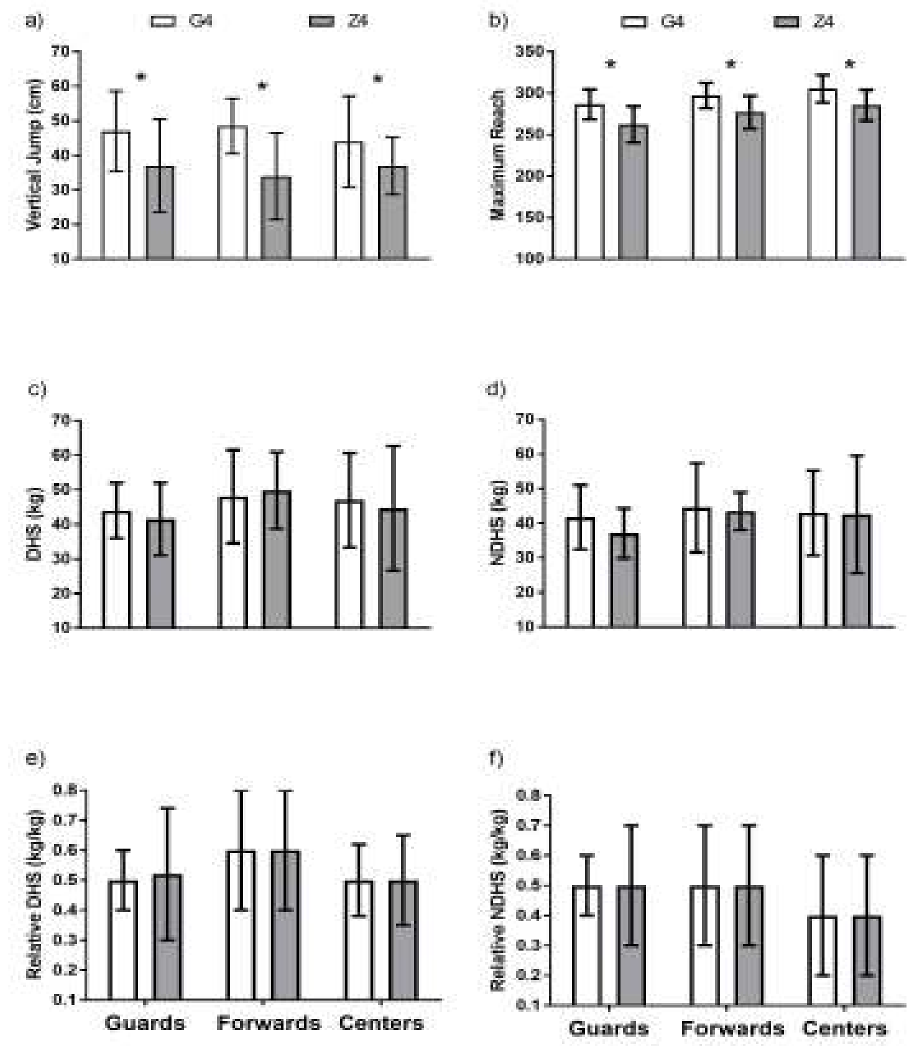

Fig. 2. Comparison of Vertical Jump (graph a), Maximum Reach (graph b) and absolute (graph c and d), and relative (graph e and f) Handgrip Strength between athletes of G4 and Z4 by playing position. DHS - Dominant Handgrip Strength, NDHS - Non Dominant Handgrip Strength.

Discussion

The main findings showed that almost all anthropometric, lower body and upper body variables assessed in this study differ in function of playing position. Additionally, confirming our hypothesis, we observed that VJ and MR scores are higher in athletes of higher ranked teams, and this is also observed when compared by playing position. However, different from what was expected, no difference was found in HS scores including hand dominance and relative strength variables.

Regarding VJ performance by playing position, it was observed a significantly superior performance in guards, forwards compared to center, which corroborates with previous studies (Abdelkrim et al., 2010). When it comes to specific player's demands, it was noted that the guards displayed higher frequency and effectivity when performing tray shot, while the forward performed more frequently and accurately the jump shot (Okazaki, Rodacki, Sarraf, Dezan, & Okazaki, 2004), which are characteristics of the stretching-contracting cycle. In this sense, it is possible to assume that greater performance of VJ in guards and forwards are linked to specific game demands, which requires the athletes to reach higher jump height during the shots. Although the centers displayed the lowest VJ, they displayed the highest MR in our study, this fact is due to their different anthropometric characteristic, such as higher height and longer arms, which is a common characteristic of this position.

Additionally to the demands associated with the game, other possible explanations for these differences are in the performance of VJ relies on the association between body fat percentage displayed by centers in comparison to guards and forwards ($p < .05$), this fact is also supported by previous studies (Abdelkrim et al., 2010; Ostojic et al., 2006). Davis et al (2003) findings corroborate with that idea, which was noted that the body fat percentage shared a variance of 62% with VJ performance, and found a negative relationship between them. In basketball, the body is constantly dislocated against gravity to perform the jumps required in shooting and rebound actions. Thus, there are no doubts that the excess of body fat is undesired because it acts as resistance when executing repetitively jumps against gravity, not providing force production (Gaurav, Singh, & Singh, 2010). Therefore, the data support the possible effect of body fat percentage as a jeopardizing factor to achieve optimal VJ height.

The analysis of VJ performance by team rank (G4 vs z4) showed that the athletes from the best ranked teams in the tournament achieved higher scores, which was also observed in the different level of performance and competition (Abdelkrim et al., 2010; Köklü, Alemdaroğlu, Koçak, Erol, & Findicoglu, 2011). Furthermore, when we compared JV and MR by performance and playing position, we observed that in all positions center, forward and guards) from G4 presented higher scores than their pairs from Z4. According to Ziv & Lidor (2009), improving VJ performance is one of the most desired goals of basketball players, and this is independent of their playing position, because attacking (shots and rebound) and defensive (block) movements require high frequency of use of this ability. In this sense, it is likely that higher VJ scores are related to higher rank classification in championship. Thus, the data suggest that there is a necessity to emphasize inferior explosive strength training in the periodization since the athletes perform an average of 44-46 jumps during a regular basketball game (Abdelkrim et al., 2007; McInnes et al., 1995).

Concerning HS, our data showed that there are significant differences in scores of HS by playing position, where the centers and forwards displayed higher scores compared do guards. Okazaki et al. (2004) investigated the players repertoire of movements during a basketball game according to their playing position, and it was found that forwards and centers are the ones who execute block and rebounds more frequently, therefore, it is possible that the playing positions can promote better performance in HS in these athletes when compared to guards. In contrast, when comparing HS performance by rank classification, it was not found any significant differences between athletes from G4 to Z4, as well as in rank classification analysis.

Due to the lack of studies with HS analysis by competitive level, it is not possible to compare our study. However, our findings are similar to Franchini et al. (2005) who found no significant difference in HS performance between elite and non elite athletes. Thus, a possible explanation to our findings may be related to the pattern of ball conduction, which does not require constant HS, but presents only during movement that involves dribbling.

Furthermore, our analysis of HS by absolute and relative strength, as well as dominant and non dominant hand, indicated no difference in either analysis (by playing position and rank). Therefore, this result in addition with the information aforementioned support the idea that HS and its related variables are likely not determinant factors or are only small contributors to performance in basketball in our sample.

Given the above, our findings support our initial hypothesis that different playing positions require different body profile and specific motor performance, besides demonstrating that the best ranked athletes displayed higher VJ and MR performance relative to the lower ranked. This provides us information that can contribute to periodization and planning of physical and technical training. However, this data must be carefully analyzed because many other factors will contribute to achieve success in sports, such as, tactical and technical aspects that were not investigated in this study. Furthermore, we believe that assessing VJ and HS only in the final of the athletes' preparation phase, without a follow-up during the competitive phase, limit us to conclude only general influence of these physical capacities to performance at the competition.

Conclusion

In this sense, it is possible to conclude that different playing position requires different body profiles and specific motor abilities, this is likely due to the necessity of specific prevalence of movements for each playing position. Moreover, we found that the athletes from the best ranked teams displayed higher VJ and MR in comparison to the athletes from lower ranked teams, this allows us to infer that VJ as a possible physical capacity that contributes to basketball success. On the other hand, HS did not demonstrate to be an important factor to athlete' success in basketball, possibly because the motor pattern of ball conduction does not often require handgrip.

Conflicts of interest- The authors declare no conflict of interest.

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