DIFFERENCES IN MOTOR ABILITIES OF VARIOUS TYPES OF EUROPEAN YOUNG ELITE FEMALE BASKETBALL PLAYERS

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Abstract:

The study is mainly aimed at determining and analysing motor abilities of European top-quality young female basketball players. Our primary interest was the development level of motor abilities of various types of players and probable differences between them. The sample of subjects consisted of 65 female basketball players from 27 European countries aged 14.49±.62 who were divided into three groups according to their playing positions (guards, forwards, centres). Using eight motor tests, we mainly investigated the players' motor abilities as follows: power of sprinting type, agility, power of throwing type and power of jumping type. Basic descriptive statistics was calculated for all the groups and the differences between them were established using ANOVA, MANOVA and MANCOVA with body height and mass as covariates. The study results show that the differences between individual player types can also be confirmed in a sample of European top-quality young female basketball players. They were distinctly differentiated in body height and mass, whereas ANOVA and MANOVA also confirmed the differences in their motor abilities. The structure of motor abilities of individual player types changes considerably if the influence of body height and mass is eliminated. The differences between them decrease and are only preserved in the technically most demanding movements performed with the ball. The differences are not only a consequence of the differences in body height but also of the different playing roles of individual types of players as well as the required technical knowledge.

Key words: *motor potential, women, guards, forwards, centres*

Introduction

Basketball is a relatively multifaceted and complex team game in which cyclic and acyclic movement structures are combined, consisting of fast and dynamic movements with the ball and without it (Erčulj & Bračič, 2007). The most frequent basketball movements include: sprints (from just a few strides to over 20 m), abrupt stops, quick changes of movement direction, acceleration, different vertical jumps, fast dribblings as well as different shots and passes (Erčulj, Dežman, & Vučković, 2004; Zwierko & Lesiakowski, 2007; Abdelkrim, El Fazaa, & El Ati, 2007). The successful and efficient execution of all these movements and, consequently, the playing performance of basketball players chiefly depend on the following motor and energy production-related abilities: power of jumping type, power of throwing type, agility with the ball and without it, coordination, speed of cyclic and acyclic movements, anaerobic lactate and alactate capacities, shooting accuracy, and ability to handle the ball (Brack, 1985; Erčulj, 1998; Jukić, Milanović, & Vuleta, 2005; Stone, 2007; Erčulj & Bračič, 2007). The playing performance of male and female basketball players is among other things determined to the largest extent by their body mass and height structure (Dežman, Trninić, & Dizdar, 2001; Karpowicz, 2006).

In basketball there are three main types of players (playing positions). We generally divide them into guards, forwards and centres, according to their playing tasks and the roles they have on the court and according to their playing position in offense. Since the role of individual types of players in the game differs (Dežman, Trninić, & Dizdar, 2001), certain differences occur between them in their model dimensions. The differences are mostly, pronounced in the morphological dimensions (Erčulj, 1998), motor potential (Trninić, Dizdar, & Dežman, 2000; Dežman, Trninić, & Dizdar, 2001; Erčulj, & Dežman, 1995; Erčulj, Dežman, & Vučković, 2002; Erčulj, Dežman, & Vučković, 2003; Erčulj, Dežman, & Vučković, 2004) and psychosocial attributes (Erčulj & Vičič, 2001).

Explosive strength, power of jumping type, speed and agility are those abilities which importantly contribute to efficient movement with the ball and without it. These abilities considerably influence the proper execution of technical and tactical elements and thus also the playing performance of all types of players (guards, forwards and centres) (Erčulj & Bračič, 2007).

In 2007 and 2008, the FIBA International Basketball Camp was organized in Slovenia for female players up to 15 years of age. It was an opportunity to measure and ascertain the motor ability profiles of the best European female players of this age. In agreement with FIBA Europe and the Basketball Federation of Slovenia, more than 70 female basketball players from 27 European countries were tested during the mentioned basketball camps. An extensive database was created which enabled us to establish a very high level of international norms for this age category. In this way we would be able to support national coaches when evaluating motor profiles of their players especially for different playing positions.

This study mainly aimed at determining and analysing the motor abilities or motor potential of top-quality young European female basketball players. Our primary interest was the development level of motor abilities of various types of players and the possible differences between them. As mentioned, literature contains plenty of studies of this subject; however, it largely focuses on male basketball players and the subjects in their samples are seldom of such a high quality. In addition, the differences between the female basketball player groups were established before and after the influence of height and mass was eliminated since these two morphological characteristics differentiated between player types and determined their playing roles.

Methods

Participants

The participants were 65 female basketball players from 27 European countries aged between 14 and 15 (average age 14.49±.62). Countries were variably represented from at least one player to up to four players. As a rule, these were the top players in their countries and members of their national teams, chosen by their national team selectors. They were all tested during the two international basketball camps held in Postojna, Slovenia. The camps took place from 25th to 30th June, 2007, and from 6th to 11th June, 2008, and were organized by the international basketball organization FIBA Europe and the Basketball Federation of Slovenia. The tests were performed within the framework of the camp programme prescribed and adopted by the Expert Council of the Basketball Federation of Slovenia and FIBA Europe. The subjects volunteered to participate in the study. The study was approved by the Committee on Scientific Research of the Faculty of Sport, Ljubljana, and the Expert Council of the Basketball Federation of Slovenia. For all participants a formal consent was given by their parents/guardian prior to the investigation. All participants were healthy and had no injuries.

The participants were divided into three groups according to their playing position. The classification by playing position was made by the coaches and was officially published by the camp organizers. The first group consisted of 35 guards. Their average age was 14.49±.61 years, body height 167.43±5.70 cm, body mass 59.32±5.99 kg and their playing experience was 5.20±1.79 years. The second group consisted of 14 forwards. Their average age was 14.57±.64 years, body height 174.09±3.79 cm, body mass 61.79±4.67 kg, and their playing experience was 5.00±2.25 years. The third group consisted of 16 centres. Their average age was 14.44±.63 years, body height 182.93±3.69 cm, body mass 69.05±7.18 kg, and their playing experience was 4.81±2.17 years.

Figure 1 shows a comparison of the three groups of players in terms of their age, playing years, body height and body mass using standardized Z-scores.

Instruments

The study was based on a test battery consisting of eight motor tests which were used to evaluate the players' selected motor abilities.

All selected tests are proven instruments in terms of their reliability and accuracy (Dežman, 1988; Erčulj, 1996). Coefficients of reliability (Cronbach's alpha) in all the cases exceeded .93. A high level of accuracy was also confirmed using factor analysis

Procedure

The height of the vertical jumps (CMJ, DJ25) was measured using the OptoJump measurement technology (Microgate, Italy). This proven measurement system (Lehance, Croisier, & Bury, 2005) from a renowned manufacturer employs optical sensors to measure the jump height on the basis of flight time. The measurer first demonstrated both tests (jumps) to each study subject and pointed out the important details related to test performance. Each subject performed the countermovement jump (CMJ) by stepping with her both feet into the OptoJump area and jumping. She was instructed to drop as fast as possible into a semi-squat position (knee angle of 90°), to push off vertically as fast and high as possible, her hands being kept on her hips from the beginning to the end of the jump, and to land on her both feet. The aim of the task was to perform the jump as high as possible. In the drop jump (DJ25) the subject was instructed to step onto the edge of a 25-cm-high bench, put her hands on her hips and jump with both feet into the OptoJump zone. Then, immediately following a landing, to perform a take-off as fast and as high as possible. After each jump the subject was informed about her performance and

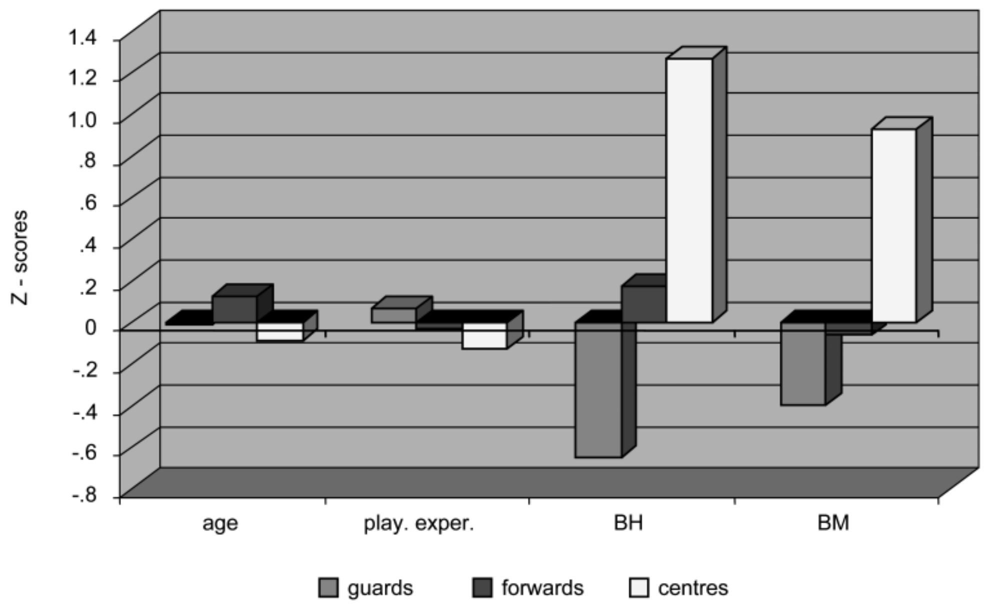


Figure 1. Comparison of the investigated different types of players in terms of their age, playing years (play, exper.), body height (BH) and body mass (BM).

Table 1. Description of the sample of variables of the motor tests

Code	Test	Main ability	Unit
CMJ	Countermovement jump	**Power** of jumping type	Jump height [cm]
DJ25	Drop jump 25 cm	**Power** of jumping type	Jump height [cm]
DJ25CT			Contact time [ms]
S20	20 m sprint	**Power** of sprinting type	Run time [s]
D20	20 m sprint dribble	**Power** of sprinting type	Run time [s]
S6x5	6 x 5 m sprint	**Agility**	Run time [s]
D6x5	6 x 5 m sprint dribble	**Agility**	Run time [s]
BBT	Basketball throw (size number 6)	**Power** of throwing type	Throw length [cm]
MBT	Medicine ball throw (2 kg)	**Power** of throwing type	Throw length [cm]

was instructed on how to perform the next jump. In the phases of jumping off the bench and landing on the ground, the knee and ankle joints had to be extended. The landing had to be on both feet. The height of both jumps (CMJ, DJ25) was measured in centimetres and the measurement accuracy was ±1 mm. The additional measurement procedure and test implementation were described by Young (1995) and Erčulj and Bračič (2007). Speed tests i.e. power of sprinting type tests (S20, D20) were conducted using a system of infra-red photocells (Brower Timing System, USA). The measurement procedure and test implementation were described in detail by Erčulj and Bračič (2007). The woman's basketball throw (BBT) and 2 kg medicine ball throw (MBT) tests were performed while the players were sitting on a chair. The measurement procedure and test implementation were also described in detail by Erčulj and Bračič (2007). The same applies to the test of agility without the ball (S6X5) and with the ball (D6X5).

Statistical analysis

Descriptive statistics was calculated for each group of basketball players. The differences among the groups were examined using multivariate analysis of variance (MANOVA) and descriptive discriminant analysis (DDA) as a follow-up procedure (Huberty, 2006). To find out which variables distinguished the groups the most, discriminant ratio coefficients (DRC) were considered (Thomas, 1992; Thomas & Zumbo, 1996). In addition, a multivariate analysis of covariance (MANCOVA) with body height (BH) and body mass (BM) as the confounding variables was conducted. The analysis was performed using SPSS (version 16.0) and R (version 2.8.1) software. P-values less than .05 were considered statistically significant.

Results

The means, standard deviations and results of the univariate tests for each group of players are presented in Table 2; the significant differences were found between the groups in all the motor tests, except *the medicine ball throw* and *drop jump contact time*. Also, the players playing different positions differed significantly in body height and body mass.

The initial MANOVA was significant (Wilks λ=.53, F(16,100)=2.35, p=.005) which shows there were differences between the positions. To further study the resulting differences, linear discriminant functions were obtained. The test of dimensionality revealed one significant discriminant function (canonical R=.65; p=.005) which accounted for 87.7% of the variance. This function separated all three positions as can be seen in Figure 1.

Table 2. Descriptive statistics of the players by their positionas

	Guards (n=35)	Forwards (n=14)	Centres (n=16)	
Variable		Mean (SD)		p*
Age	14.49 (.61)	14.57 (.65)	14.44 (.63)	.839
Playing years	5.20 (1.80)	5.00 (2.25)	4.81 (2.17)	.806
Height (cm)	167.43 (5.70)	174.09 (3.79)	182.93 (3.69)	<.001
Mass (kg)	59.32 (6.00)	61.79 (4.67)	69.05 (7.18)	<.001
S20	3.53 (.16)	3.57 (.15)	3.76 (.18)	<.001
D20	3.81 (.21)	3.85 (.28)	4.11 (.23)	<.001
BBT	713.14 (70.70)	772.14 (54.23)	766.25 (82.86)	.009
MBT	442.35 (39.93)	458.57 (27.41)	466.66 (49.23)	.122
S6X5	9.42 (.51)	9.54 (.45)	9.87 (.42)	.009
D6X5	10.23 (.54)	10.34 (.65)	10.78 (.68)	.015
CMJ	27.66 (4.32)	27.76 (3.63)	24.36 (3.39)	.019
DJ25	26.42 (3.89)	25.17 (4.44)	23.24 (3.99)	.038
DJ25CT	250.91 (64.15)	238.36 (56.64)	247.00 (57.53)	.810

Legend: S20 - 20 m sprint; D20 - 20 m sprint dribble; BBT - basketball throw; MBT - medicine ball throw; S6X5 - 6 x 5 m sprint; D6X5 - 6 x 5 m sprint dribble; CMJ - countermovement jump; DJ25 - drop jump 25 cm height.

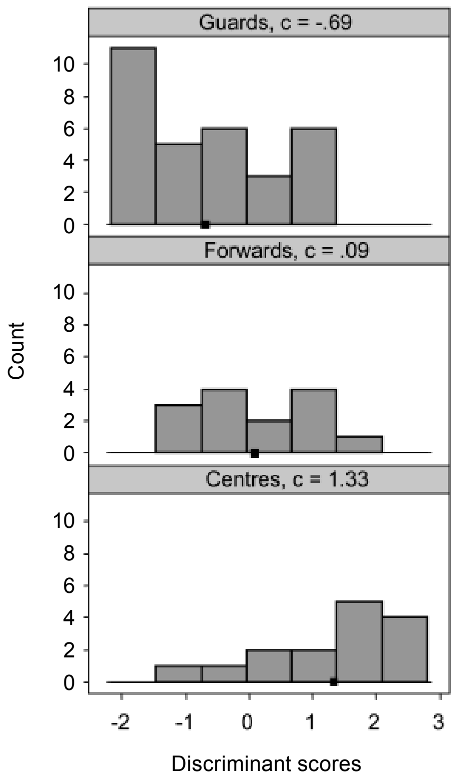


Figure 2. Distributions of discriminant scores and group centroids (c).

The discriminant ratio coefficients (Table 3) suggest that the best variable for distinguishing between the positions is the *20m sprint*, followed by the *basketball throw*, *6 x 5m sprint* and *medicine ball throw*. According to the unadjusted means (Table 2), the centres performed worst in both sprint tests, but they were the best in throws. Group differences on the motor tests were also

Table 3. Discriminant ratio coefficients (DRC)

Variable	DRC
S20	.398
D20	.077
BBT	.200
MBT	.128
S6X5	.185
D6X5	.041
CMJ	.008
DJ25	-.037

Legend: S20 - 20 m sprint; D20 - 20 m sprint dribble; BBT - basketball throw; MBT - medicine ball throw; S6X5 - 6 x 5 m sprint; D6X5 - 6 x 5 m sprint dribble; CMJ - countermovement jump; DJ25 - drop jump 25 cm height.

examined using MANCOVA with height and mass as covariates. This time the global test was not significant (Wilks λ=.80, F(16,96)=.73, p=.760). In Figure 3 a comparison of the unadjusted and adjusted means (Table 4) is presented.

In the group of forwards the unadjusted and adjusted means were similar for all the tests, while in the other two groups the differences were substantial, especially in the *basketball throw*, *medicine ball throw*, *countermovement jump* and *drop jump* tests.

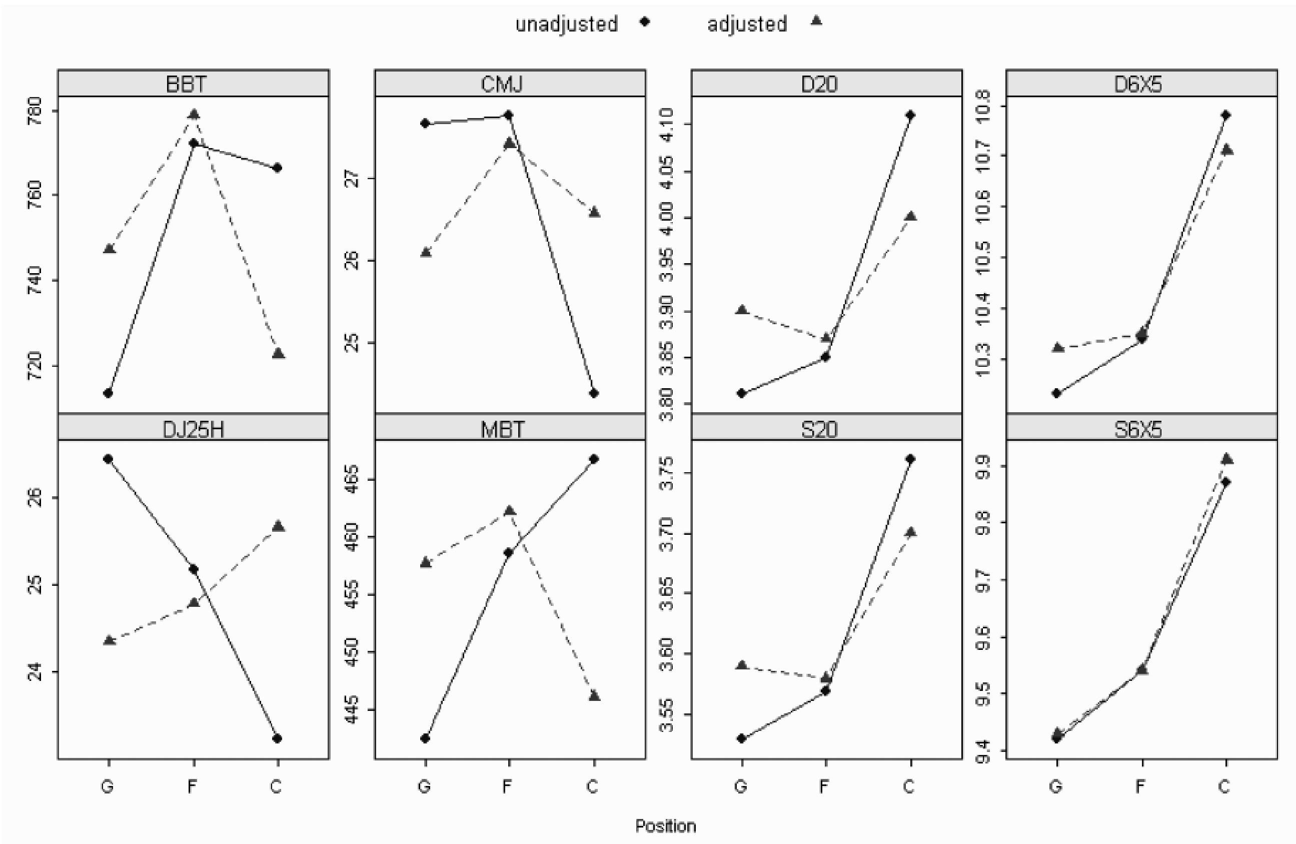
Table 4. Adjusted means after MANCOVA

Variable	Guards	Forwards	Centres
S20	3.59	3.58	3.70
D20	3.90	3.87	4.00
BBT	747.15	778.88	722.50
MBT	457.66	462.17	446.06
S6X5	9.43	9.54	9.91
D6X5	10.32	10.35	10.71
CMJ	26.08	27.41	26.57
DJ25	24.35	24.78	25.65

Legend: S20 - 20 m sprint; D20 - 20 m sprint dribble; BBT - basketball throw; MBT - medicine ball throw; S6X5 - 6 x 5 m sprint; D6X5 - 6 x 5 m sprint dribble; CMJ - countermovement jump; DJ25 - drop jump 25 cm height.

Discussion and conclusions

Basketball is a sport in which three types of players are recognized. They assume different playing roles which require players of a suitable height. It is therefore only natural that in our study of European top-quality young female basketball players statistically significant differences between player types in terms of their body height and body mass were established (Figure 1, Table 2). As expected, the tallest and heaviest players were the centres, followed by the forwards, whereas the guards were the shortest and lightest players. These marked differences in body height across playing positions result in a specific profile and/or structure of motor abilities of individual player types. The previous findings were also confirmed by ANOVA which revealed statistically significant differences in most motor tests (Table 2). In the tests of the *power of sprinting type* and *agility without the ball* (S20, S6X5) and *with it* (D20, D6X5) the guards scored the best, and were followed by the forwards and centres. Such results had been



Legend: BBT - basketball throw; CMJ - countermovement jump; D20 - 20m sprint dribble; D6X5 – 6 x 5 m sprint dribble; DJ25H - drop jump 25 cm height; MBT - medicine ball throw; S20 - 20 m sprint; S6X5 – 6 x 5 m sprint.

Figure 3. Comparison of the unadjusted and adjusted means.

expected; they were also congruent with some previous studies (Erčulj, Dežman, & Vučković 2002; Erčulj, Dežman, & Vučković 2003; Erčulj, Dežman, & Vučković 2004) and corresponded to the guards' playing role. Important elements of this role are rapid changes of movement directions when faking, penetrating or getting open as well as pronounced acceleration over a longer distances in the ball transition to the front (as in a fast-break) or to the back court (as in covering the opposing fast- -breakers). ANOVA showed (Table 2) the statistically significant differences in the height of both vertical jumps (CMJ, DJ25H). In both tests, the most inferior group of players was the group of centres whose both slow and fast (eccentric-concentric) power of jumping type was least developed. Guards and forwards achieved better results which were on average almost equal. Such results are no surprise as they confirm the findings of previous studies (Erčulj, Dežman, & Vučković 2004; Erčulj & Bračič, 2007); however, they do not entirely correspond to the playing role of the centres. During a game, centres are expected to execute the highest number of jumps (Abdelkrim, El Fazaa, & El Ati, 2007). They often rebound after missed shots in defense and offense alike, catch high passes under the basket and block shots of their opponents from close to the basket. The abilities measured by the mentioned two tests are much welcome in centres. In the tests of power of throwing type (BBT, MBT) the results differed from the previous ones, with the guards scoring the lowest results and the forwards and centres scoring higher and quite equivalent results. Similar results were already established by Erčulj and Bračič (2007) who also stated the reasons for this. However, the results obtained do not benefit the guard's playing role. More often than the other players in a team, guards shoot at the basket from a greater distance and perform long passes (Erčulj, 1998). Therefore, the power of throwing type is an ability which considerably affects their performance (Erčulj, 1996). However, the results of both tests to some extent reflected the absolute strength of the arms and the shoulder girdle. This ability also facilitates efficient contact play in the crowd under the basket, which is particularly important for tall players (forwards and especially centres).

As already mentioned in the Introduction, the differences in motor abilities between the individual types of basketball players have already been established and confirmed by previous studies; however, these mainly applied univariate methods (ANOVA, *t*-test). Therefore, we also aimed at corroborating the differences by using a multivariate analysis of variance (MANOVA) and discriminant analysis. Both MANOVA (p=.005) and discriminant analysis (Table 3, Figure 2) corroborated the differences between the individual types of players. Given the results of the discriminant analysis (Table 3) it can be established that the player types differed mostly in terms of the results of the tests with the ball (S20, S6X5). Movements with the ball are more complex and more demanding in terms of coordination. Therefore, they are most efficiently and rapidly executed by the guards whose technical skill/knowledge is generally better. So, of all the players in a team they dribble the ball the most (Erčulj, 1996). The playing role of centres does not require such a high level of technical skills, especially ball handling, whereas the forwards are somewhere between the guards and the centres. Given that individual player types differed considerably in terms of their body height and body mass (Figure 1, Table 2), we decided to establish whether there were any differences between them even after the influence of both measures had been eliminated. As shown by the results, MANCOVA generally failed to reveal statistically significant differences between the player groups (p=.760) in motor test results. In most of the tests, the adjusted means after MANCOVA differed substantially from the unadjusted means (Table 3). This was particularly true of the guards and centres whose results were usually most distinctive, whereas the means of the forwards did not change considerably. A comparison of the unadjusted and adjusted means (Figure 2) revealed that the biggest differences occurred between both throws (BBT, MBT) and jumps (CMJ, DJ25H). These were the tests where body height and body mass influenced the results most strongly. In the first two tests (BBT, MBT) the influence of body height and body mass was positive which is why the adjusted means of the centres decreased and those of the guards increased. In the other two tests (CMJ, DJ25H), the influence of body height and body mass was negative as expected. The adjusted means of the guards decreased and those of the centres increased. In both sprints (S20, D20), the influence of body mass and height was slightly weaker. The difference between the guards and centres diminished, although the guards achieved higher adjusted means after MANCOVA. In the sprinting involving the changing of direction (S6X5, D6X5), the differences in means before and after the elimination of body weight and body mass were minimum, so it can be concluded that the two body dimensions had practically no influence on the results. A comparison of the results of D20 before and after MANCOVA revealed that when the influence of body height and body mass was eliminated the differences between the guards and the centres decreased more than in the V20 test. Something very similar was observed in the D6X5 test when compared to the S6X5 test. In our opinion, this again demonstrated that the guards had a better dribbling technique than the centres.

In view of the previously said it can be concluded that in a sample of European top-quality young female basketball players the differences between individual types of players can also be confirmed. The player types were markedly differentiated in terms of their body height and body mass. The differences were also established in most of the measured motor abilities. They were not only a consequence of the differences in body height but also of the different playing roles assigned to the individual types of players as well as of the required technical skills. The structure of motor abilities of guards, forwards and centres changed considerably when the influence of body height and body mass was eliminated. The differences between them decreased and were only preserved in the technically most demanding movements performed with the ball.

These findings on the structure and level of motor abilities of different types of female basketball players of such high quality are undoubtedly very important for both basketball theory and practice. They enable the generation of model values which can greatly assist basketball coaches and researchers.

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RAZLIKE U MOTORIČKIM SPOSOBNOSTIMA VRHUNSKIH EUROPSKIH MLADIH KOŠARKAŠICA RAZLIČITIH IGRAČKIH POZICIJA

Glavni je cilj ovog istraživanja bilo utvrđivanje i analiza stanja motoričkih sposobnosti vrhunskih europskih mladih košarkašica. Primarni interes istraživanja bio je utvrditi razvojni status motoričkih sposobnosti košarkašica različitih igračkih pozicija i definiranje razlika među njima. Uzorak ispitanica činilo je 65 košarkašica iz 27 europskih zemalja, u dobi od 14,49±0,62 godine. Podijeljene su u tri skupine prema svojim igračkim mjestima - branići, krila i centri. Uporabom 8 testova za procjenu motoričkih sposobnosti definirano je stanje sljedećih motoričkih sposobnosti: eksplozivna snaga tipa sprinta, agilnost, eksplozivna snaga tipa bacanja i eksplozivna snaga tipa skoka. Za sve grupe ispitanica izračunati su osnovni statistički parametri te su, za utvrđivanje razlika među njima, korištene ANOVA, MANOVA i MANCOVA, kod koje je za tjelesnu visinu i tjelesnu masu provedena analiza kovarijance. Rezultati istraživanja potvrdili su da razlike među igračicama različitih igračkih pozicija postoje i u uzorku vrhunskih europskih mladih košarkašica. Mlade košarkašice se izrazito razlikuju po tjelesnoj visini i težini, a ANOVA i MANOVA otkrile su i razlike u razini razvijenosti njihovih motoričkih sposobnosti. Struktura motoričkih sposobnosti pojedine skupine košarkašica značajno se mijenja ukloni li se utjecaj tjelesne visine i težine. Razlika među njima tada se smanjuje i ostaje očuvana samo u tehnički najzahtjevnijim kretnim strukturama koje se izvode loptom. Može se zaključiti kako razlike među grupama ispitanica nije samo posljedica razlike u visini, već ona postoji i zbog različitih igračkih uloga pojedinog tipa igračica, kao i zbog zahtijevane razine tehničkog znanja.

Ključne riječi: *motorički potencijal, žene, bekovi, krila, centri*