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DIFFERENCES BETWEEN BASIC TYPES OF YOUNG BASKETBALL PLAYERS IN TERMS OF DIFFERENT JUMPS HEIGHT AND GROUND CONTACT TIME

RAZLIKE V VIŠINI IN KONTAKTNEM ČASU RAZLIČNIH SKOKOV TREH OSNOVNIH TIPOV MLADIH KOŠARKARJEV

Abstract

The aim of this study was to establish whether there were any differences in various types of jumps between three types of young basketball players, namely in terms of two- and one-leg jumps which are the most frequent type of jumps in basketball. For this purpose we sampled 50 male basketball players, aged 16 and 17, who were the top basketball players of their age group in Slovenia. The sample was further divided into three subsamples: guards (n=18), forwards (n=18) and centres (n=14). Based on the results of the analysis of variance and the discriminant analysis it may be concluded that individual types of players differ greatly in terms of results of all five tests (jumps). In all five tests the best results (height or length of jump) were achieved by guards, followed by forwards and centres. In terms of contact time (duration of take-off) the differences between the three types of players were not so obvious and were statistically significant only in two cases.

Key words: basketball, young players, jump height, contact time

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Izvleček

V raziskavi smo želeli ugotoviti, ali obstajajo razlike v višini oz. dolžini različnih vrst skokov med tremi tipi mladih košarkarjev oziroma tistimi skoki s sonožnim in enonožnim odrivom, ki se največkrat pojavljajo v košarkarski igri. V ta namen smo v vzorec igralcev izbrali 50 košarkarjev, starih 16 in 17 let, ki predstavljajo najboljše košarkarje svojega letnika v Sloveniji. Vzorec igralcev smo razdelili še na tri podvzorce: branilce (n=18), krila (n=18) in centre (n=14). Glede na rezultate analize variance in diskriminantne analize lahko rečemo, da se posamezni tipi igralcev močno razlikujejo v rezultatih vseh petih uporabljenih testov (skokov). V vseh namreč najboljše rezultate (višino ali dolžino skoka) dosegajo branilci, sledijo jim krilni igralci in nato centri. V kontaktnem času (časa trajanja odriva) razlike med tremi tipi igralcev niso tako očitne in so le v dveh primerih statistično značilne.

Ključne besede: košarka, mladi igralci, višina skoka, kontaktni čas

Introduction

Basketball is an attractive, fast and dynamic ball game with many fans in Slovenia as well as other European countries. Thanks to high quality of expert and scientific work in the field of basketball Slovenia, in spite of small population (less than two million) and a relatively weak economic strength, achieves very good results at the club level and within the scope of the national team. Particularly successful are our young players regularly qualifying for European championships. In recent years Slovene national teams have even become the European champions and vice-champions in the categories of young men and junior men.

Basketball is a game of a very explosive nature characterised by short sprints, abrupt changes of direction, sudden stops and various jumps. Successful and efficient performance of numerous jumps in basketball is enabled by the ability which is most often called take-off power. In basketball this capacity manifests itself in many situations, namely when players jump with the ball and without it, during the defence or in offence. A play itself starts with a jump (opening jump ball), which evidently symbolises the significance of the take-off power in basketball. Most frequently players rebound after a field shot or after a free throw. Players often jump when passing the ball (jump passing) or when catching it. Most of the shots at the basket are usually jump shots and the players jump also when attempting to block a shot. In addition to the above mentioned jumps and more or less vertical jumps, which prevail in basketball, some jumps are also made horizontally. These are most frequent during penetration from standing position, dribbling penetration and lay-up shot after a cut under the basket.

The take-off action or act of movement which is called take-off usually consists of two parts, namely the eccentric and concentric muscle actions, although it can be comprised of concentric contraction only (Knutgen & Komi, 2003). In the first phase muscle action produces the lengthening of muscle fibres while developing tension resulting from the running start speed or body weight. After the jump the power may be higher as it is developed by the extensor muscles of knee, ankle and hip joints. It is called the amortisation phase or the phase of eccentric muscular action. It is followed by the phase of concentric muscular action. Here muscle power is stronger than resistance, which is why muscular joints approach and the extensor muscles of leg act concentrically.

During basketball jumps power usually develops by a combination of eccentric and concentric muscular contractions. In this type of jumps, the muscle is stretched prior to the shortening (concentric contraction). During the stretching the elastic components of the muscle store elastic energy, which is released if the shortening is followed immediately (according to Bosco (1999) in 190 ms). The elastic energy release is found to increase the force production during the shortening up to 20-30% (Tossavainen, 2004).

One- or two-leg jumps are typical of basketball. They may be made from standing position or with different running starts, and are more or less characterised by swinging of the arms. In some of the examined studies dealing with this subject (Gorjan, 1993; Mahorič, 1994) the authors identified 30 to 60 different jumps performed by a player during a match. Of course this also depends on the type of player or his role. In basketball two-leg jumps prevail. Gorjan (1993) for example identified as much as 86% of two-leg and only 14% of one-leg jumps. Two-leg jumps may be performed from standing position, nevertheless, it is more often that pressure is exerted on the extensor leg muscles as a consequence of the weight power after the previous running start or landing. Preparations before take-off or running take-off vary in different circumstances. Usually the player turns and makes one step or takes off after two or more quick steps.

We believe players lacking take off power seldom become successful, as they may only partially compensate for this weakness by other factors of successful basketball playing. Players with well developed take-off power are more successful in execution of modern technical and tactical elements of basketball and vice versa – the use of take-off power depends on the level of mastery of techniques of individual jumps.

Same as other team games, basketball is also characterised by distinct playing positions. Individual playing position is determined by the role a player plays in a game. Division of players by player position and their role in a play are of particular importance in basketball and primarily depend on organisation and/or playing tactics in offence and defence.

There are three basic playing positions or types of players in basketball: guards, forwards and centres. Beside the adequate level of technical and tactical knowledge successful playing at a given position and high performance of a particular role require suitable dimensions of players' psychosomatic status. As individual player roles result in specific movement structure and require a special structure of dimensions of psychosomatic status, individual types of players differ in terms of morphological, motor, functional and psycho-social dimensions. In view of the characteristics of individual player roles and basketball as such it may be said that motor abilities are particularly important, as they define to the greatest extent players' potential, performance and efficiency (Dežman, 1987; Erčulj, 1998). Among them take-off power undoubtedly has an important role.

In this study we tried to establish whether there were any differences in various types of jumps between three types of young basketball players, namely in terms of two- and one-leg jumps as they are the most frequent types of jumps in basketball.

Method

Participants

The sample consisted of 50 players, born in 1986 and 1987. In 2003, when the measurements were carried out, 29 players turned 17 and 22 players 16 years of age. All players were included in the comprehensive lists of junior men or cadet men national teams of Slovenia and were therefore the top basketball players of their age group in Slovenia. The cadet-men national team ranked 6th at the 2003 European Championship, while that of junior men qualified for the 2004 European Championship. All players had at least four years' status of basketball players. The sample of players was divided into three subsamples: guards (n=18), forwards (n=18) and centres (n=14).

Instruments

Five measuring instruments were used in this study to assess take-off power (described in Table 1). Each test focusing on muscular activity and co-ordination of agonists and antagonists represented one of the predominant types of jumps in real situations in a game.

Table 1: Description of measuring instruments

Test	*Most frequent application in a play*
SOM (counter-movement jump)	Rebounding after a field shot or after free throw, standing jump shot, shot blocking.
SO1K (counter-movement jump with one-stride run)	Rebounding after a field shot or after free throw, jump shot with one-step run, shot blocking, referee's jump ball.
SO40 (drop jump from 40 cm)	Jump for the ball after previously failed rebounding, rebounding after a previous missed shot under the basket, jump shot or jump for the ball after two-leg stopping.
EOZ (one-leg jump with run)	All shots with one-leg take-off, rebounding with running start and one-leg take-off.
TRM (triple jump from standing position)	Penetration from standing position, lay-up shot after cut, penetration from dribbling.

Procedure

With the first four tests the height of vertical take-off (take-off impulse directed upwards) was measured and with the fifth one (TRM) the length of horizontal take-off (take-off impulse directed forwards).

The result of each vertical jump was read on the measuring board fastened to the basketball backboard. We calculated the height of take-off (jump), subtracting the achieved height, which was first measured for all players, from the result of an individual test. In horizontal jumps (TRM) the result was measured and read on the measuring band. Thus, the following variables were obtained:

EOZH – Height of one-leg jump with run [cm],
SO40H – Height of drop jump from 40 cm [cm],
SOMH – Height of counter-movement jump [cm],
SO1KH – Height of counter-movement jump with one-stride run [cm],
TRML – Length of triple jump from standing position [cm].

In all tests contact time, i.e. duration of take-off, was also measured, except in the SOM test (it was not possible). We used the ERGO TESTER device (Globus, Italy), which measures contact time in milliseconds. Thus, the following variables were obtained:

EOZC – Contact time (take-off time) of one-leg jump with run [ms],
SO40C – Contact time of drop jump from 40 cm [ms],
SO1KC – Contact time of counter-movement jump with one-stride run [ms],
TRMC1 – Contact time of the second take-off in triple jump (the first one-leg take-off) [ms],
TRMC2 – Contact time of the third take-off in triple jump (the second one-leg take-off) [ms].

Owing to some additional analyses of the relation between take-off power and certain morphological dimensions and due to methodological requirements, the following morphological measurements were also included in the test battery:

ATV – body height [cm],
ATT – body weight [kg],
AT/AV – ratio between body weight and body height,
AKGN – skin fold of upper arm [mm],
AKGT – skin fold of abdomen [mm].

For all variables the following was calculated: descriptive statistics, Kolmogorov – Smirnov goodness of fit test, one-way ANOVA and discriminant analysis.

Results

First we calculated the basic parameters of descriptive statistics for all variables and established normality of distribution with the Kolmogorov – Smirnov test.

Table 2: Descriptive statistics and Kolmogorov – Smirnov goodness of fit test

Variable	*Mean*	*S.D.*	*Min*	*Max*	*K-S Sig. all*	*K-S Sig. G*	*K-S Sig. F*	*K-S Sig. C*
ATV	191.47	7.79	170.00	210.00	.541	.691	.958	.697
ATT	81.09	9.85	59.80	116.50	.632	.932	.357	.518
AT/AV	42.37	4.51	35.00	57.00	.669	.935	.637	.637
AKGN	63.18	28.43	28.00	152.00	.209	.983	.239	.976
AKGT	138.75	72.87	60.00	360.00	.270	.198	.744	.707
SO40H	48.94	5.47	36.00	60.00	.306	.698	.921	.576
SOMH	52.96	5.89	40.00	61.00	.308	.912	.752	.998
SO1KH	55.50	6.58	37.00	68.00	.557	.867	.965	.989
EOZH	66.72	6.97	51.00	82.00	.934	.847	.902	.495
TRML	706.60	48.39	578.00	797.00	.955	.952	.523	.955
SO40C	264.84	42.68	192.00	407.00	.712	.857	.994	.931
SO1KC	220.92	41.31	142.00	364.00	.456	.407	.510	.925
EOZC	242.78	26.84	195.00	298.00	.934	.957	.970	.899
TRMC1	332.26	41.98	253.00	431.00	.862	.446	.994	.993
TRMC2	300.20	33.03	240.00	387.00	.660	.645	.988	.621

Legend:
G – guards; F – forwards; C – centres
ATV – body height [cm],
ATT – body weight [kg],
AT/AV – ratio between body weight and body height,
AKGN – skin fold of upper arm [mm],
AKGT – skin fold of abdomen [mm].
SO40H – Height of drop jump from 40 cm [cm],
SOMH – Height of counter-movement jump [cm],
SO1KH – Height of counter-movement jump with one-stride run [cm],
EOZH – Height of one-leg jump with run [cm],
TRML – Length of triple jump from standing position [cm].
SO40C – Contact time of drop jump from 40 cm [ms],
SO1KC – Contact time of counter-movement jump with one-stride run [ms],
EOZC – Contact time (take-off time) of one-leg jump with run [ms],
TRMC1 – Contact time of the second take-off in triple jump (the first one-leg take-off) [ms],
TRMC2 – Contact time of the third take-off in triple jump (the second one-leg take-off) [ms].

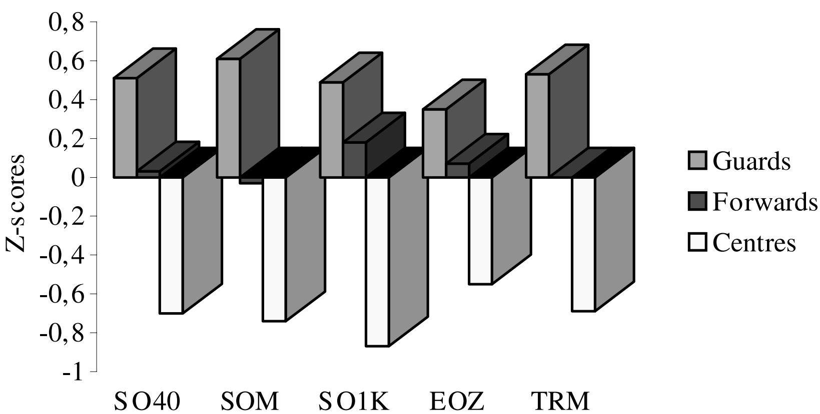
Given the results shown in Table 2 it may be concluded that the values of all variables are normally distributed, which paves the way for further data processing.

Table 3: Differences between individual types of players (One-Way ANOVA)

Variable	*Mean Guards*	*S.D. Guards*	*Mean Forwards*	*S.D. Forwards*	*Mean Centres*	*S.D. Centres*	*F ratio*	*F prob*
ATV	185.23	7.15	191.70	3.09	199.63	4.59	29.53	0.000
AT	74.75	6.13	81.12	8.00	89.65	10.00	13.98	0.000
AT/AV	40.05	3.05	42.80	4.10	45.08	5.50	5.46	0.007
AKGN	52.55	14.70	61.71	28.75	81.66	35.71	4.32	0.018
AKGT	108.88	50.62	132.57	68.89	194.33	81.51	6.11	0.004
SO40H	51.77	2.84	49.11	6.16	45.07	5.03	7.50	0.001
SOMH	56.55	3.05	52.77	5.68	48.57	6.14	9.85	0.000
SO1KH	58.77	4.08	56.72	5.81	47.71	6.64	11.29	0.000
EOZH	69.16	5.94	67.27	6.64	62.85	7.37	3.67	0.032
TRML	732.50	37.81	706.72	39.46	673.14	52.78	7.49	0.001
SO40C	259.94	45.72	254.11	24.07	284.92	52.41	2.36	0.105
SO1KC	222.55	45.51	215.16	42.94	226.21	35.09	0.29	0.746
EOZC	231.38	23.51	241.50	25.97	259.07	25.33	4.89	0.011
TRMC1	323.05	44.55	322.83	35.42	356.21	39.32	3.48	0.038
TRMC2	290.76	28.75	290.72	29.21	323.85	32.44	6.08	0.004

Legend (see Table 2)

Figure 1: Differences between guards, forwards and centres in standardized Z-scores



The results in Table 3 and Figure 1 show that the best results in all tests of take-off power were those of guards, followed by forwards, while centres' results were the poorest in all five tests. In four tests the differences were statistically significant – 1% error (SO40H, SOMH, SO1KH, TRML) and in one test the error was 5% (EOZH). It has to be emphasised that centres are lagging considerably behind the other two types of players, which is most apparent in the SO1KH variable.

The differences between the three types of players in terms of contact time (duration of take-off) were not so obvious and were statistically significant only in two or three cases (EOZC, TRMC1 and TRMC2) – 5% error. In spite of all that it should be noted that centres recorded the longest contact time in all five tests.

The differences between both groups were additionally analysed by the Canonical Discriminant Analysis (see Table 4).

Table 4: Canonical discriminant functions

Fcn	*Eigenvalue*	*Pct of Variance*	*Cum Pct*	*Canonical Corr*	*After Fcn*	*Wilks' Lambda*	*Chi-square*	*df*	*Sig.*
					0	0 .545094	27.306	10	.0023
1	.5626	76.37	76.37	.6000	1	.851739	7.221	4	.1246
2	.1741	23.63	100.00	.3850					

The algorithm of discriminant analysis eliminated two discriminant functions, of which the first was statistically significant and accounted for the majority of total system variance (76.3%).

Table 5: Standardised canonical discriminant function coefficients (SDC) and correlations between discriminating variables and canonical discriminant function (CDC) for function 1

	SDC	*CDC*
TRML	.414	.746
EOZH	-.447	.527
SO1KH	.706	.918
SO40H	.343	.750
SOMH	.023	.849

Legend (see Table 2)

Table 6: Group centroids and classification results

Actual	*Group*	*Predicted*	*Group*	*Membership*
Group	Centroids	1	2	3
1 (guards)	.720	13 (72.2%)	4 (22.2%)	1 (5.6%)
2 (forwards)	.131	5 (27.8%)	10 (55.6%)	3 (16.7%)
3 (centres)	-1.094	3 (21.4%)	2 (14.3%)	9 (64.3%)

The proportion of correct classifications was 64%. This means that the discriminant function successfully differentiates both groups. Five guards (out of 18), eight forwards (out of 18) and five centres (out of 14) were not classified into their group (see Table 6).

The highest standardised canonical discriminant function coefficients (SDC) (see Table 5) have variable SO1KH, for which the analysis of variance established that it most strongly differentiated between individual types of players (see Table 2). It was slightly lower in variables TRML and SO40H, while in the remaining two variables it was either zero (SOMH) or even negative (EOZH). The highest correlation with the first discriminant function (CDC) again had the variable SO1KH (Table 5), nevertheless, correlations of other variables were not much lower and all exceeded 0.527.

Discussion

The achieved results are difficult to evaluate and compare with the results of other studies. There are practically no studies mentioned in professional literature dealing with the same issues on a sample of young basketball players and possibly applying the same or similar tests. A comparison of the results from the study conducted by Erčulj (1993) shows that the results of most of the tests (SOM, SO1K, EOZ, TRM) (see Table 2) are only slightly higher than those achieved by one year younger club level basketball players and as such they may not be assessed as good. In drop jump (SO40) the selected players achieved even worse results than one year younger club level players from 50 cm drop height. We may also conclude that in the same test the players from our sample lagged behind their peers from the Italian national team – measured by Bosco (1999) – for about 4 cm, while they achieved about the same results in TRM as one year younger players of the Croatian national team (Milanović, Jukić, Dizdar, & Šentija, 1996).

It must also be noted that the tested players achieved (for about 4 cm) better results in test SOM compared to test SO40. Some authors (e.g. Chu, 1992; Dežman & Erčulj, 2000) use the difference between these two tests as a tool for measuring the development of the elastic component of take-off power. Athletes with well developed elastic power usually achieve higher height of jump from drop height 40 cm than after standing counter-movement jump. In the literature we may find data on optimal drop height of drop jump, that is the height at which the measured players achieve the best result (the highest take-off). The latter may even exceed 45 cm, e.g. in the case of volleyball players (who are otherwise in senior-men age category) (Bosco, 1999).

All of the above indicates a relatively poorly developed elastic component of take-off power of selected players. These findings were also confirmed by Čoh (1988), who established a relatively low value or index of elastic power of basketball players and concluded that elastic power of basketball players was inferior to that of some other athletes (e.g. track and field jumping, volleyball, handball, football). A comparison reveals slightly better results of basketball players in tests in which the result is primarily influenced by the explosive component of take-off power.

Based on the results of the analysis of variance and the discriminant analysis it may be established that individual types of players differ greatly in terms of results of all five tests of take-off power. There is a strong heterogeneity between all of the three groups of tested players. In all five tests (jumps) the best results (height or length of jump) were achieved by guards, followed by forwards and centres (see Table 3). It has to be stressed that centres, when compared to guards and forwards, achieve substantially poorer results in all tests and obviously have the least developed take-off power. Slightly better results of centres were expected primarily in tests SO1KH (height of two-leg counter-movement jump with one-stride run) and SOMH (standing two-leg counter-movement jump), as it is particularly the centres that jump frequently in that way in a play. Their basic position in offence and defence is in the vicinity of the basket or area to which the ball most often bounces off after a missed shot. In addition, the area below the basket is most crowded so that many times centres do not have enough time and room to take a (longer) run. It is also interesting that in the SO1KH test (height of two-leg counter-movement jump with one-stride run) centres achieved poorer results than in the SOMH test (standing two-leg counter-movement jump). Apparently they are not capable of taking advantage of the running start and/or transform the additional horizontal force (speed) into stronger vertical take-off impulse. It is therefore not surprising that according to the results of the analysis of variance and the discriminant analysis it is obviously the SO1KH test result that draws the clearest distinction between individual types of players.

Centres achieve the poorest results also in horizontal triple jump (TRML), despite the fact that their higher height and longer legs could give them advantage compared to other types of players. Taking the above into account, the poor results of the test one-leg jump with run (EOZH) and the long contact time in both tests show that centres' elastic component of take-off power is poorly developed. It has to be added here that these kinds of jumps are not so frequent in the movement structure of centres, namely, centres are making them less often during a play compared to the other two types of players.

Based on the measured contact times (duration of take-off) (Table 1) it can be said that the take-off of basketball players of a selected sample is relatively long or slow. In vertical jumps the shortest contact time was recorded in the SO1K test (220 ms) and the longest in the SO40 test (264 ms) (in the SO1K test the contact time was measured only for one leg – the one with which the tested player took a running start). The contact time was even longer in horizontal triple jump (332 ms and 300 ms in the first and second one-leg take-off, respectively). For example, Čoh and colleagues established that the optimal time of one-leg take-off with run of top high jumpers was 127 to 150 ms and that very similar results were recorded with long jumpers (Čoh & Mikuž, 2002; Čoh, Novak, & Jošt, 2002). Similar values were also presented by Zatsiorsky (2003), only that they were slightly lower with long jumpers (105 to 125 ms). Relatively long contact times, i.e. take-offs, were observed also in jumps with a two-leg take-off. For example, Bosco (1999) considers contact time ranging from 145 to 160 ms to be "excellent" in drop jumps. He classified contact times of 160 to 175 ms into the category "good" and all times exceeding 190 ms into the category "poor" or "modest". However, the author failed to state sports event and age of athletes.

Longer contact time, i.e. take-off of basketball players, is probably a consequence of lower squat position and use of higher number of muscles or muscle groups (primarily quadriceps femoris) when taking-off. Jumps with run or jumps following landing or stopping are probably characterised by taking off with the entire foot and touching the ground with the heel. Based on these long contact times it may be assumed that the majority of basketball players from our sample (primarily centres) are either very inappropriately using their elastic component (energy) or this component of their take-off power is poorly developed. The reason for long contact times in take-off may also lie in insufficiently developed maximum power (especially with centres) and to some extent also in particularity of jumps. As players touch one another (contacts and also pushes) they must take a stable position before jumping and during a jump. This may only be achieved in a way that is described above (the Americans call these jumps "power jumps" or "power jump shots"). Most of the jumps are made with two-leg take-off from spot, after pivoting or after two-leg stopping (e.g. most cases of rebounding after a shot at basket, in majority of shots at basket, in shot blocking, in referee's jump ball). Players have enough time to take a lower squat position and swing their arms. While preparing for a jump or jumping, they often have to adjust their speed to the circumstances of the play, which is why jumper's success does not depend only on his take-off power and achieved height but also on correct and timely positioning before the jump and the timeliness of the take-off (Gorjan, 1993).

Specificity of take-off in basketball is a consequence of particular morphological structure of basketball players. This is primarily true for centres, as they are the heaviest and have most extra fat mass (see Table 2). It is therefore not surprising that centres are the ones who achieve the longest contact times in all of the tests. It is interesting that there are practically no differences between guards and forwards in terms of contact time and that forwards usually achieve slightly shorter times. It also has to be stated that among the top centres of the present times there are more and more good athletes with highly developed maximum and take-off powers.

However, relatively low levels of take-off power development may not be attributed only to specificity of the sample of players and special jumping technique that basketball players apply. We assume that inadequate conditioning is also the culprit, especially the segment dedicated to the development of various types of powers. This is particularly true of centres, as they are selected on the basis of their body height and less because of their motor abilities.

It is obvious that centres are the ones who jump the most during a game and that jump is one of the major criteria when assessing performance and efficiency of centres in a play. As a matter of fact, this contradicts our study, as we have just established that take-off power of centres was the least developed. In our opinion most attention should be devoted to the development of maximum and explosive powers of centres, as their play is mostly characterised by jumps in which these two abilities prevail. In addition, plyometric training that influences chiefly the development of the elastic component of take-off power is particularly risky in the case of very high or heavy players, such as centres, whose maximum power of leg and loin muscles is not developed enough. This does not mean that the development of elastic component of take-off power should be neglected. This component is strongly present in centres' play, and even more in that of guards and forwards. Specifics of individual types of players as well as individual players as such have to be considered, and load during such training dosed accordingly.

This study raised some questions about young basketball players' take-off power that have not yet been answered. We expect that more helpful data on characteristics of basketball players' take-off power and its development will be obtained when similar research will have been conducted with older age groups and when players' results of selected take-off power tests will have been compared to their jumping efficiency in a play.

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