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RELATIONSHIP BETWEEN 1RM BACK SQUAT TEST RESULTS AND EXPLOSIVE MOVEMENTS IN PROFESSIONAL BASKETBALL PLAYERS

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ABSTRACT

The objectives of this study were related to the research of the relations between the abilities of professional basketball players in the performance of one repetition maximum (1RM) back squat and explosive movements, such as 5, 10 and 20-metre running, and vertical jump; as well as the detection and comparison of these abilities between players who play on the outside and inside positions. The study involved 35 professional basketball players (22 outside and 13 inside) who were selected as candidates for the national team of Bulgaria. Independent variables of muscular strength were obtained by applying the 1RM back squat test (142.06 ± 29.31 kg), and were normalized with respect to the body mass (*1RM Squat/kg* (1.51 ± 0.25)) and by applying suitable allometric exponent (*1RM SquatAl* (6.86 ± 1.16)). Dependent variables were obtained using two tests: *20-metre run* (times registered at 5 and 10 metres) and *vertical jump* (used to calculate the variable *peak anaerobic power (PAPW)*). The results indicated that none of the variables of strength were significantly related to the speed performance, while moderate correlations occurred between the normalized strength variables (*1RM Squat/kg* and *1RM SquatAl*) and vertical jump ($r = 0.310$ and $r = 0.308$ / $p < 0.05$). The results obtained show greater correlation ($r = 0.660$ / $p < 0.01$) in the ability to deliver power when performing squat and mechanical work performed in vertical jumps. Outside and inside players were significantly different in three variables only: *peak anaerobic power, body height and body weight*.

Keywords: vertical jump; acceleration; peak anaerobic power; testing

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INTRODUCTION

Basketball is an intermittent and dynamic activity that consists of short but very intense activities, followed by longer or shorter periods of passive or active rest, during which a basketball player recovers (Spencer et al., 2005; Taylor, 2004). It has complex requirements based on a combination of individual skills, team play, tactics and motivational aspects (Trninic & Dizdar, 2000). During the game, players perform a series of tasks typical for each player, which are based on a certain motor, technical and tactical skills; success in the realization of greater number of tasks, which players perform in the game, is achieved by quick actions on a relatively small space (Trninic et al., 2010a; Trninic et al., 2010b). Abdelkrim et al. (2007) registered 1050 ± 51 different actions of an individual player during a basketball game. These actions include different movements, such as running, dribbling, shuffling, and jumping, which are multidirectional, intense and short-lasting (Crisafulli et al., 2002). This is why basketball practice must contain sprint and strength training, agility exercises with emphasis on technique, and the development of perception and decision making (Young & Farrow, 2006). Therefore, coaches should emphasise short and intense activities (speed and agility) as well as testing of vertical jump, agility T-test, sprints over very short distances (5 or 10 m), etc. (Cronin et al., 2003).

Undoubtedly conditioning is very important for success in professional basketball. Basketball-conditioning coaches pay the most attention to the training and testing of specific speed (agility and acceleration) and strength/power (Simenz et al., 2005).

Lower body strength is particularly important in basketball. It is the foundation of a basketball player's explosive movements. Maximum strength is the base for the development of specific forms of power and the ability of players to quickly generate as much force as possible is very desirable in basketball. This requires optimal muscular strength of the lower extremities (Zatsiorsky, 1995).

In strength training for the lower body of basketball players, along with ballistic multi-joint exercises, back squat exercises with variations are used (Hedrick, 1993; Simenz et al., 2005). It is well known that the back squat is a very useful exercise because it involves movement of several joints (ankle, knee and hip joints) and thereby engages a large number of muscle groups (Bachle et al., 2000; Chandler & Stone, 1992). In addition, the exercise has the necessary neuromuscular specificity and positive transfer to the basic sports activities (Garhammer, 1981; Zatsiorsky, 1995).

Except for the purpose of training maximum strength of the lower extremities, the back squat is often used as an effective exercise of specific warm-up and preparation for the execution of explosive movements, primarily jumps (*post-activation potentiation*). Therefore, the acute effects of back squat performance on explosive movements have been the subject of several studies (Stieg et al., 2011; Sotiropoulos, et al., 2010; Witmer et al., 2010).

In contrast, there are studies that have researched the relationship between the present or general skills in the performance of back squat and explosive movements. They showed strong correlation between maximal strength in half squats and sprint performance and jumping height (Carlock et al., 2004; Chelly et al., 2010; Chelly et al., 2009; McBride et al., 2009; Wisløff et al., 2004). In order to enhance jumping power output, maximum strength in the back squat exercise has to be improved and included as a dominant part of training programs (Stone et al., 2003). Since in these studies the athletes (they were not basketball players) were of different levels of sport mastery, or age, the obtained correlations are expected and understandable.

The (main) idea of this study was to investigate these capabilities in professional basketball players as a homogenous representative group (sample), as well as their interrelations, primarily related to importance of explosive movements in basketball.

It is assumed that the current capabilities of professional basketball players in back squat performance with a maximum load would have a positive influence on their explosive movements, which are very common and important in basketball.

Furthermore, it is well known that in basketball, primarily on the basis of morphological characteristics and then according to specific duties during the play, there are two main types of players: inside and outside players (Trninic et al., 2010a; Trninic et al., 2010b). There is a common idea in practice that these two types of players differ in general skills in the performance of back squat and explosive movements. Inside players are stronger and outside ones are more explosive. The intention of this study was to verify this notion with reliable representative sample of players.

The primary objective of this study was to examine the correlation between professional basketball players' abilities to perform back squats with a maximum weight and explosive movements, such as running at 5, 10 and 20 m, and on vertical jump. The secondary objective was related to the detection and comparison of these abilities between outside and inside basketball players. As far as we know, there has not been any study that researched these relationships on such a homogenous and representative group (sample) of professional basketball players.

MATERIAL AND METHODS

Participants

The study sample included 35 professional Bulgarian basketball players of the First Bulgarian Basketball League (average age 21.37 ± 2.91 years). Experts of the Bulgarian Basketball Federation choose them since they were the best national players and candidates for the national team. Two subgroups were formed according to their playing position: outside players (playing positions 1, 2 and 3 – N = 22), average age 20.90 ± 2.09 years, and inside players (playing positions 4 and 5 – N = 13), average age 22.15 years ± 3.91. We selected more outside players, because they are also more numerous in a game. Specifically, during a basketball game, there are three outside and two inside players among five players on the court, or among 12 players of basketball team there are usually 8(7) outside and 4(5) inside players. Thus, a similar relation of outside and inside players should also be formed in national selections. The subjects provided their written consent and participated voluntarily in the measurements that had been approved by the Ethical Committee of Faculty of Sport and Physical Education, University of Belgrade.

Measures and Procedures

Dependent variables. Two tests were applied: a 20-metre sprint run, and a vertical jump test. The *20-metre sprint run* was conducted on a marked track in a basketball hall, with photocells (*Micro Gate, Italy*) positioned at 5, 10 and 20 metres from the starting line and at 1-metre height. The subjects started from a standing position with a foot sticking out at a distance of 70 cm from the first photocell and were assigned to run the distance of 20 metres as quickly as they could. In that way, three variables were acquired, expressed in seconds(s): *running time of 5 metres (Run5m), running time of 10 metres (Run10m) and running time of 20 metres (Run20m).*

The Reach Vertical jump test was applied according to the instructions given by Bloomfield et al. (1994). The player dips his fingers of the right hand in gym chalk, stands beside the wall and makes mark on the wall after reaching as high as possible without lifting the heels from the floor. This value is recorded, after which player jumps as high as possible without taking a step, marking the wall at the peak of the jump. The difference between this height and standing reach height (to the nearest 0.5 cm) is recorded as the variable *Vertical jump*. The best score out of three attempts is recorded. From this variable, a variable *peak anaerobic power* is calculated (*PAPw*) using the formula given by Sayers et al. (1999):

PAPw (Watts) = 60.7 × jump height (cm) + 45.3 × body mass (kg) – 2055

Independent Variables. They were obtained by applying the *back squat* test (variable *1RM Squat*). The testing protocol given by Bachle et al. (2000) was used. Lifting was successful if, in the lowest point of the squat, the thigh was parallel to the ground before lifting (determined visually) and if the load was lifted without assistance. An Olympic bar of 20 kg was used (*Panatta Sport, Italy*). The maximum lifted weight was normalized in two ways: in relation to kg of body mass (*1RM Squat/kg*) and using allometric formula ($S_n = Sm^{2/3}$; S_n – normalized force, S-force obtained in test, m-body mass) for obtaining the index of muscle strength developed by Jaric (2002), the variable *1RM SquatAl*. In addition, *body height* was measured with a stadiometer (*Seca 220, UK*) as well as *body mass* with portable scales (*Tanita BF683W, GER*).

Statistical Analysis

The data were first processed using basic descriptive statistics, with which the following were calculated: arithmetic mean (M), standard deviation (SD), minimum (Min) and maximum values (Max). Relationships between variables were calculated using correlation analysis (Pearson). The Regression analysis–Stepwise method was used for investigation of the independent variables' impact on the dependent variables. In examining the differences between the two groups of players, an independent sample *t-test* was used, and the effect size (Cohen) was calculated. Levels of significance were set at $p < 0.01$.

RESULTS

Descriptive parameters for outside and inside players and a comparison of these two groups, (t-test) are shown in Table 1. The differences between outside and inside players in terms of dependent and independent variables were not so obvious and were statistically significant only in the variables PAPw, body height and body mass. For these variables, the value of effect size was calculated. There are almost medium differences between groups in the variable PAPw ($r = 0.385$). On average, outside players achieved better results in three acceleration variables: run 5, 10 and 20 metres, but inside players achieved better results in 1RM Squat (maximum lifted weight) and vertical jump.

Table 1. Descriptive statistics of all variables – outside and inside players; and results of t-test

Variable	Outside players (N = 22)			Inside players (N = 13)			t-test
	Mean ± SD	Max.	Min.	Mean ± SD	Max.	Min.	t
1RM Squat (kg)	136.18 ± 28.01	210.00	95.00	152.00 ± 29.85	210.00	108.00	–1.58
1RM Squat/kg	1.51 ± 0.29	2.32	1.00	1.50 ± 0.16	1.79	1.26	0.09
1RM SquatAl	6.77 ± 1.30	10.42	4.56	7.00 ± 0.91	8.58	5.54	–0.55
Run 5 m (s)	1.05 ± 0.05	1.17	0.96	1.07 ± 0.06	1.18	0.98	–1.18
Run 10 m (s)	1.79 ± 0.07	1.95	1.68	1.82 ± 0.09	2.00	1.69	–1.09
Run 20 m (s)	3.03 ± 0.11	3.20	2.81	3.10 ± 0.15	3.48	2.90	–1.67
Vertical jump (cm)	58.31 ± 6.21	70.00	45.90	59.00 ± 5.94	71.00	47.00	–0.32
PAPw (W)	5567.70 ± 499.53*	6647.00	4421.90	6072.00 ± 694.44*	7235.50	5118.60	–2.82

* Sig. ($p < 0.01$); ** Variables measured in time units have reverse character so, higher value means worse result

Table 2. Correlation coefficients between variables

Variables	Run 5 m	Run 10 m	Run 20 m	Vertical jump	PAPw
1RM Squat	0.110	0.247	0.243	0.267	0.660**
1RM Squat/kg	–0.103	–0.014	–0.047	0.310*	0.215
1RM SquatAl	–0.024	0.089	0.065	0.308*	0.403**

* Sig. ($p < 0.05$); ** Sig. ($p < 0.01$)

Table 2 shows a strong correlation between the variables 1RM Squat and PAPw, as well as between variables 1RM Squat and Body mass. Medium-high correlation coefficients were obtained between the variable 1RM Squat Alom and PAPw. There are no significant correlations between independent variables and variables of acceleration and vertical jump, except between the variable vertical jump and variables 1RM Squat/kg and 1RM SquatAl.

The stepwise method of regression analysis obtained a significant influence of the independent variables only on the dependent variable PAPw. Therefore, the results of a regression analysis are presented in Table 3, only for the dependent variable PAPw. In the first step, the variable 1RM Squat is extracted, and in the second variable 1RM SquatAl is.

Table 3. Results of regression analysis, Stepwise method: dependent variable – *PAPw*, predictors – *1RM Squat*, *1RM Squat/kg* and *1RM SquatAl*

Model Summary ANOVA				
Model	R	R^2	F	Sig.
1	0.69	0.47	29.32	0.00
2	0.93	0.87	109.53	0.00

Coefficients					
Model	B	Std.Error	Beta	t	Sig.
1 (Constant) First step	90.35	12.87		7.02	0.00
1RM Squat	0.48	0.09	0.67	5.42	0.00
2 (Constant) Sec. step	1385.27	7.92		17.30	0.00
1RM Squat	1.08	0.07	1.56	14.53	0.00
1RM SquatAl	–88.31	8.80	–1.07	–10.04	0.00

DISCUSSION

The subjects achieved very similar results of running at a distance of 5 metres and almost identical results at a distance of 20 metres in comparison to the results of other professional basketball players from the available studies (Staff, 2000). Furthermore, they are similar in terms of vertical jump (Ziv & Lidor, 2010), back squat (Hunter, 1993), as well as of body height and body mass (Staff, 2000). Therefore, these data have a suitable value and may be included in the database for the subsequent research in the population of professional basketball players.

The results of comparison (t-test) between the two groups of players (Inside and Outside players) were expected. Similar results can be found in the literature in some tests of strength or speed for basketball players at different positions (Bache et al., 2000; Staff, 2000). In contrast, these results disprove certain prejudices resulting from basketball practice that outside players are able to accelerate more quickly and that inside players are more powerful. They nominally differ in these abilities, i.e. the average results in the speed tests are better for outside players, while in tests of maximal strength the average results are better for inside players, but not statistically significantly. Statistically significant differences in body height and body mass were expected, as well as in the variable PAPw due to the significantly higher body mass of inside players. The higher value of peak anaerobic power that the inside players have shows their greater potential to perform mechanical work.

The results indicated that none of the variables of strength (1RM Squat, 1RM Squat/kg, 1RM SquatAl) significantly correlated to the speed performance of basketball players. It can be assumed that these strength variables explain the variance of execution of treated speeds in this sample to a very small extent. Similar findings were reported by Baker and Nance (1999) in which they found no significant relationship between a 3RM squat and the sprint performance at 10 m ($r = -0.06$) and at 40 m ($r = -0.19$) in professional rugby league players. A statistically significant lack of correlation ($r = 0.3$) between the squat (1RM) and the 40 m sprint performance was also reported by Wilson et al. (1996).

It can be assumed that certain specificities of squat performance and speed performance result in the obtained correlation. The specificity of the contraction regime in squat performance suggests that there is little similarity in the movements of acceleration/deceleration implicit in the movement of limbs in speed performance (Cronin & Hansen, 2005). Consequently, in terms of *speed specificity*, during the squat the speeds that are realized are different from real sprint speeds, in which, as the distance and speed increase, fast SSC performance has a growing importance and contribution to the movement. A special feature is the number of involved joints and joint kinematics and dynamics during movement and during tests they are usually significantly different from the ones measured during sprint running. Since closed kinetic chains, i.e. movements that include multiple joints are used during the sprint realization, the legitimacy and the relation between the use of iso-inertial and/or isokinetic measurements and sprint performance can be questioned.

Given that the size of the realized force and the speed of muscle contraction according to the *F-v relation* are inverse, it follows that overdeveloped force (provided that it is not converted into explosive power by training) negatively affects the expression of running speed, especially in the phase of maximum running speed. Since fast performance of SSC is realized during running, for its realization an overdeveloped force extends the time of transition from eccentric to concentric muscle contraction (coupling time). In that way, a negative transfer is achieved and this extends the phase of foot contact with the ground during sprint. It is known that the duration of contact with the ground, frequency and the length of step are decisive factors in the realization of maximum running speed (Luhtanen & Komi, 1978; Mero & Komi, 1994). These allegations are based on our assumption that the subjects in the sample developed a high level of expression of maximum force, and that they did not *convert it into a specific (explosive and speed) power*, and therefore it has *no impact on the results of the run at 5, 10 and 20 m*. Specifically, the force developed by training represents a latent ability whose positive transfer in maximum running speed is only possible through the conversion of force into explosive and speed power.

Relatively moderate correlations between vertical jump and 1RM Squat, especially when the force obtained in the squat test is normalized as described above, suggest that, because of the similar patterns of movement during squats and jumps, there is a significant relationship between these measurements. The vertical jump is a typical test of explosive power ($E = F/t$). It can be influenced by increasing the force with the same performance speed (of muscle contraction) or by increasing the speed of the jump performance with the same level of force. Therefore, an explosive jump is that with the optimal ratio of developed force and possible speed of the muscle contraction performance. It is known that an increase in force reduces the possible speed of movement performance until the performance of maximum isometric force at which the speed of movement performance (muscle contraction) is zero, and the power is also equal to zero (Jaric, 1997). According to the results shown in Table 1 (subjects achieve even 210 kg in half squat), it can be assumed that the players have either developed the force that is greater than the optimal, or have not converted enough force to an explosive and speed power, so in this case there is no positive transfer of the achieved level of force on the expression of results in explosive power. It can be assumed that the average jump height (58.31 ± 6.21 cm, 70.00 cm = max, min = 45.90 cm) is not at the highest level, according to Ostojić et al. (2006) who state that the average vertical jump is higher than 70 cm, and other statements of Latin et al. (1994), according to Ostojić et al. (2006), that the average jump is 71.4 ± 10.4 cm. The assumption is that these players have developed a level of force, but on the basis of jumping ability (M = 58.57 ± 6.04), it is evident they do not have a pronounced ability to increase the rate of force development (RFD); therefore, a high level of force demonstration is reached relatively slowly, i.e., during a long time. If the force achieved by training by applying an appropriate method converts to explosive power, then it has a more significant and positive impact on the vertical jump and running at 5 m and 10 m. In these activities when the inertia of the body is overcome, the transfer of force is greater, because during start relatively slower SSC performance is implemented and there is more time to generate force.

The resulting correlation indicates a relatively greater connection between the ability to produce force when performing squats (1RM Squat) and mechanical work performed in vertical jump (PAPW). The results of regression analysis (values of coefficient of determination R^2) show that maximal force affects on peak anaerobic power (Table 3). Variable 1RM Squat is separated in the first step of regression and that significantly influence on peak anaerobic power ($R^2 = 0.47$). Variable 1RM SquatAl is separated in the second step, so far synergic effect of these two variables are even more important determines the peak anaerobic power. Values of 1RM are revitalized with the introduction of variable 1RM SquatAl, what has contributed that the impact force to the peak anaerobic power increases by 40%. This can be explained by the fact that allometric parameter reconciles the heterogeneity of the sample in terms of the body dimensions that are typical in the basketball team. Since the mechanical work (A) depends on the realized force (F) at the distance (s), and realized power is directly proportional to the work performed ($P = A/t$), the power reached is a direct function of the realized force. Considering that there is an effect of force in a squat (1RM Squat) on the vertical jump, especially if it is normalized, then a high correlation between half squat (1RM Squat) and the power realized during vertical jumps is expected, and expressed as PAPW ($r = 0.660$; $p < 0.01$).

CONCLUSION

In conclusion, according to the presented results, basketball players achieved similar results in almost all variables as other professional basketball players from literature did. The acquired results support the assumption that they either developed force that is greater than optimal, or they did not sufficiently convert the developed force to explosive and speed power, and in this case there was no positive transfer of the achieved level of force on the expression of the results in speed performance.

It was shown that inside and outside players are not significantly different in back squat, sprint variables and vertical jumps. There were significant differences in in the variable of peak anaerobic power (PAPW) in favour of inside players. The higher value of peak anaerobic power that the inside players have shows their greater potential to perform mechanical work.

REFERENCES

Abdelkrim, B. N., Elfazaa, S., El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *Brit J Sport Med*, 41(2), 69–75.

Bachle, T. R., Earle, R. W., Wathen, D. (2000). *Resistance training*. *Essentials of strength training and conditioning*. Champaign, IL: Human Kinetics.

Baker, D., Nance, S. (1999). The relation between running speed and measures of strength and power in professional rugby league players. *J Strength Cond Res*, 13, 230–235.

Bloomfield, J., Ackland, T., Elliot, B. C. (1994). *Applied Anatomy and Biomechanics in Sport*. Melbourne: Blackwell Scientific Publications.

Carlock, J. M., Smith, S. L., Hartman, M. J., Morris, R. T., Ciroslan, D. A., Pierce, K. C., Newton, R. U., Harman, E. A., Sands, W. A., Stone, M. H. (2004). The relationship between vertical jump power estimates and weightlifting ability: a field-test approach. *J Strength Cond Res*, 18, 534–539.

Chandler, J. T., Stone, M. H. (1991). The squat exercise an athletic conditioning: a position statement and revise of the literature. *Strength Cond J*, 13(5), 51–60.

Chelly, M. S., Cherif, N., Amar, M. B., Hermassi, S., Fathloun, M., Bouhlel, E., Tabka, Z., Shephard, R. J. (2010). Relationships of peak leg power, 1 maximal repetition half back squat, and leg muscle volume to 5-m sprint performance of junior soccer players. *J Strength Cond Res*, 24(1), 266–271.

Chelly, M. S., Fathloun, M., Cherif, N., Amar, M. B., Tabka, Z., Van Praagh, E. (2009). Effects of a back squat training program on leg power, jump, and sprint performances in junior soccer players. *J Strength Cond Res*, 23(8), 2241–2249.

Crisafulli, A., Melis, F., Tocco, F., Laconi, P., Lai, C., Concu, A. (2002). External mechanical work versus oxidative energy consumption ratio during a basketball field test. *J Sport Med Phys Fit*, 42, 409–417.

Cronin, J. B., Hansen, K. T. (2005). Strength and power predictors of sports speed. *J Strength Cond Res*, 19(2), 349–357.

Cronin, J. B., McNair, P. J., Marshall, R. N. (2003). Lunge performance and its determinants. *J Sport Sci*, 21(1), 49–57.

Hedrick, A. (1993). Strength and power training for basketball. *National Strength and Conditioning Association Journal*, 15(4), 31–36.

Hunter, G. R., Hilyer, J., Forster, M. A. (1993). Changes in Fitness During 4 Years of Intercollegiate Basketball. *J Strength Cond Res*, 7(1), 26–29.

Jarić, S. (1997). *Biomechanics of human locomotion with sports biomechanics*. *The second revised edition*. Belgrade: Dosije.

Jarić, S. (2002). Muscle strength testing: use of normalisation for body size. *Sports Med*, 32, 615–631.

Luhtanen, P., Komi, P. V. (1978). *Mechanical factors influencing running speed*. In: E. Asmussen, K. Jorgensen (Eds.). Baltimore: University Park Press, 23–29.

McBride, J. M., Blow, D., Kirby, T. J., Haines, T. L., Dayne, A. M., Triplett, N. T. (2009). Relationship between maximal squat strength and five, ten, and forty yard sprint times. *J Strength Cond Res*, 23(6), 1633–1636.

Mero, A., Komi, P. V. (1994). EMG, Force, and Power Analysis of Sprint-Specific Strength Exercises. *J Appl Biomech*, 10(1), 1–13.

Ostojić, S. M., Mazić, S., Dikić, N. (2006). Profiling in basketball: physical and physiological characteristics of elite players. *J Strength Cond Res*, 20, 740–744.

Sayers, S. P., Harackiewicz, D. V., Harman, E. A., Frykman, P. N., Rosenstein, M. T. (1999). Cross-validation of three jump power equations. *Med Sci Sport Exer*, 31(4), 572–577.

Simenz, C. J., Dugan, C. A., Ebben, W. P. (2005). Strength and conditioning practices of national basketball association strength and conditioning coaches. *J Strength Cond Res*, 19(3), 495–504.

Sotiropoulos, K., Smilios, I., Christou, M., Barzouka, K., Spaias, A., Douda, D., Tokmakidis, S. P. (2010). Effects of warm-up on vertical jump performance and muscle electrical activity using half-squats at low and moderate intensity. *Journal of Sports Science and Medicine*, 9, 326–331.

Spencer, M., Bishop, D., Dawson, B., Goodman, C. (2005). Physiological and metabolic responses of repeated-sprint activities specific to field-based tem sports. *Sports Med*, 35(12), 1025–1044.

Stieg, J. L., Faulkinbury, J. K., Tran, T. T., Brown, L. E., Coburn, J. W., Judelson, D. A. (2011). Acute effects of depth jump volume on vertical jump performance in collegiate women soccer players. *Kinesiology*, 43(1), 25–30.

Stone, M. H., O'bryant, H. S., McCoy, L., Coglianese, R., Lehmkuhl, M., Schilling, B. (2003). Power and maximum strength relationships during performance of dynamic and static weighted jumps. *J Strength Cond Res*, 17(1), 140–147.

Taylor, J. (2004). A tactical metabolic training model for collegiat basketball. *Strength Cond J*, 26(5), 22–29.

Trninić, S., Dizdar, D. (2000). System of the performance evaluation criteria weighted per positions in the basketball game. *Collegium Antropol*, 24(1), 217–234.

Trninić, S., Karalejić, M., Jakovljević, S., Jelaska, I. (2010a). Structural analysis of knowledge based on principal attributes of the game of basketball. *Physical Culture*, 64(1), 5–25.

Trninić, S., Karalejić, M., Jakovljević, S., Jelaska, I. (2010b). Structural analysis of knowledge based on specific attributes of the game of basketball. *Physical Culture*, 64(2), 22–41.
Vanderburgh, P. M., Katch, F. I., Choenleber, J., Balabinis, C. P., Elliot, R. (1996). Multivariate allometric scaling of men's world indoor rowing champion performance. *Med Sci Sport Exer*, 28, 626–630.
Wilson, G. J., Murphy, A. J., Walshe, A. (1996). The specificity of strength training: The effect of posture. *J Appl Psychol*, 73, 346–352.
Wisløff, U., Castagna, C., Helgerud, J., Jones, R., Hoff, J. (2004). Strong correlation of maximal squat strength with sprint performance and vertical jump height in elite soccer players. *Brit J Sport Med*, 38(3), 285–288.
Witmer, C. A., Davis, S. E., Moir, G. L. (2010). The acute effects of back squats on vertical jump performance in men and women. *Journal of Sports Science and Medicine*, 9, 206–213.
Young, W., Farrow, D. (2006). A review of agility: practical applications for strength and condiditoning. *Strength Cond J*, 28(5), 24–29.
Zatsiorsky, M. V. (1995). *Science and practice of strength training*. Champaign, IL: Human Kinetics.
Ziv, G., Lidor, R. (2010). Vertical jump in female and male basketball players – A review of observational and experimental studies. *Journal of Science and Medicine in Sport*, 13, 332–339.

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