SCIENTIFIC WORK REVIEW

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DEVELOPMENT OF AGILITY IN BASKETBALL PLAYERS

Abstract

Modern elite basketball is a dynamic game. Its dynamism, among other things, is due to the high level of development of physical condition of each player, regardless of his position in the game. Therefore, great attention is paid to physical preparation, both within the main, technical and tactical training, as well as on special trainings that exclusively work on the development of motor skills primarily. One of the motor skills which is very important for basketball is agility. It is defined by motor tasks composed of fast running with frequent changes of direction. The aim of this study was to gather previous studies that have dealt with the development of agility in basketball players. For collection, classification and analysis of the targeted research, the descriptive methods and theoretical analysis were used, and the researches that have been reached were searched on Google, Google Scholar, PubMed and Kobson. The search was limited to works that were published in the period from 2009 to 2021. Total of 21 researches were found. The results showed that the most commonly used method for development of agility is plyometric training method, in male as well as in female basketball players. Several studies show that the agility of players can be developed by a combination of plyometric training and any other training. The results also show that, in addition to plyometric training, agility in basketball players can also be developed by SAQ training, a combination of strength training, endurance and basketball techniques, then by proprioceptive training and skipping rope workout.

***Key words**: basketball, development, agility, motor skills, change of direction*

1. INTRODUCTION

Basketball is a sport game and belongs to the sports of complex motor activities, which have a variable-interval character, with the aerobic-anaerobic (glycolytic) energy security. In such sports, motor actions have a dynamic character and manifest themselves with very large variability in the long term, in terms of compensatory fatigue (Željaskov, 2004). Requirements for the manifestation of specific forms of movement in basketball depend on different positions of players, but these differences disappear with the development of the game of basketball, given the tendency that players today have high abilities of movement on the ground (Verstegen & Marcelo, 2010). Success in this collective sports game depends on a number of factors in the domain of the equation of specification of success in basketball. This is a dynamic sports game which is characterized by complex structures of movement and dealing with it successfully requires possessing of certain motor skills (Kocić and Berić, 2015). *Agility* is a motor ability which is very important for basketball (Nikolić, Kocić, Berić & Jezdimirović, 2015). The term *agility* is not easy to explain, because it represents the synthesis of almost all physical abilities that athletes possess (Verstegen & Marcelo, 2010). It is defined by motor tasks composed of fast running with frequent changes of direction. Motor structures of this type are very common in the game, since, due to changes in the situation, the players

are required to start quickly, to run fast and change direction as well as to stop quickly (Jovanović, 1999). An athlete who has a high degree of agility can expect to have advantages in his sport. Possession of optimal agility reduces the possibility of injury, has impact on the improvement of sports achievement and on neutralizing opponents, and avoiding of opponents by using deception to avoid the body. Agility also contributes to the ability of a successful manipulation of the external object (props), such as ball (Verstegen & Marčelo, 2010). The ability of quick stops and changes of direction is an obvious example of physical fitness that provides conversion of the classic speed to a specific speed in almost all sports (Kremer & Gomez, 2010). Some authors define it as "a quick coordination", because it involves movement structures in which there is a rapid moving of body in space, while keeping the primary motor task to be structuring of movements (Jovanović, 1999). Since most of the tasks in basketball are done on a relatively small area, while insisting on the speed of implementation of the complete structure of the movement, it is assumed that the results on the tests of agility are significantly affected by the ability to develop maximum force. This is special because, in majority of the tasks, it is necessary to master a relatively large force of inertia in moments of change in direction (Kocić, 2007). The subject of this work is agility of basketball players. The aim of this study was to gather previous studies that have dealt with the development of agility in basketball players.

2. RESEARCH METHODS

For collection, classification and analysis of the targeted researches, the descriptive methods and theoretical analysis were used, and the researches that were reached were searched on Google, Google Scholar, PubMed and Kobson. Additional literature in the form of textbooks was also used. The search was limited to works that were published in the period from 2009 to 2015 and the works in which the authors investigated the development of agility in basketball players. The analyzed scientific studies were published in journals that have a significant impact factor. Key words used in the search were: agility, development and basketball.

THEORETICAL CONSIDERATION OF PROBLEMS

For a better review, all previous researches on this topic are represented in Table 1. 21 researches were presented. Each research is shown by the following parameters: sample of respondents (the total number of respondents, age and gender) and the experimental treatment (duration of the experiment, the number of groups in the course of research, the parameters that were measured, notes, the results of the program and the difference between groups at the end of the experiment) . The number of respondents in researches quite varied from one research to another. The smallest number of respondents was in research by Lehnert, Hůlka, Malý, Fohler & Zahálka (2013) and amounted to 12 respondents, the largest in research by Abraham (2015) and amounted to 80 respondents. In five studies the respondents were female basketball players (Chaudhary & Jhajharia, 2010; Dadwal, 2013; Komal & Singh, 2013; Zaric, 2014; McCormick et al., 2015), in one study there were male and female (Ramachandran & Pradhan, 2014), and in all other studies were male players. The youngest sample was in research by Andrejić (2012) and Ramateerth & Kannur (2014), and ranged from 12 to 13 years, and the oldest sample of respondents was in research by Lehnert, Hůlka, Malý, Fohler & Zahálka (2013) in which participants were an average age of 24.36 ± 3.9. The experimental treatment lasted the least in research by Ramachandran & Pradhan (2014) and amounted to two weeks. The experimental treatment had the longest duration in research by Shallaby (2010), Abraham (2015) and Ademović (2015) and lasted for 12 weeks. In one study it lasted for 10 weeks (Dadwal, 2013); in four studies it lasted for 8 weeks (Arazi, Coetzee & Asadi, 2012; Mitra, Bandyopadhyay & Gayen, 2013; Komal & Singh, 2013; Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel, 2014); in ten studies it lasted for 6 weeks (Chaudhary & Jhajharia, 2010; Bal, Kaur, Singh & Ball, 2011; Asadi & Arazi, 2012; Andrejić, 2012;

Živković, 2012; Asadi, 2013; Lehnert, Hůlka, Malý, Fohler & Zahálka, 2013; Ramateerth & Kannur, 2014; Zaric, 2014; McCormick et al., 2015); in two studies it lasted for 4 weeks (Shaji & Isha, 2009; Boccolini, Costa & Alberti, 2012). In most of the works, the program involved exercising 2 to 3 times a week. All the studies that are shown in Table 1, in addition to investigating the development of agility in basketball players, also explored the development of other skills on the aforementioned sample. However, regarding the subject of the research, we presented only agility in Table 1, as one of the most important skills for basketball.

Table 1 – Sample of respondents (**N**-total number, **Age**-age, **G**-gender of respondents) and **experimental treatment** (duration of the experiment, **Nb. of Gr**.-number of groups, the measured parameters, notes, results of the program, the differences between groups at the end of the experiment)

Reference	**Sample of respondents**			**Eksperimental treatment**					
	N	Age	G	duration	Nb.of Gr.	measured parameters	note	results	differences between groups
Shaji & Isha (2009)	45	18-25	M	4 weeks (2x a week)	1Di 1P 1DiP	agility	/	agility increase at **P** and **DiP**	/
Chaudhary & Jhajharia (2010)	20	18-22	F	6 weeks	1P 1K	agility	/	**P** group significantly increased agility	**K** group did not have a significant increase
Shallaby (2010)	20	16	M	12 weeks (3x a week/ 120min)	1P 1K	shuttle running test	/	improvement of all measured parameters of motor skills at **P**	**P** greater improvement of all measured parameters compared to **K**
Bal, Kaur, Singh & Bal (2011)	30	18-24	M	6 weeks (2x a week / 25min)	1P 1K	agility	for assessment of agility agility *T*-test and Illinois Agility Test were used	improvement of agility	/
Asadi & Arazi (2012)	16	19-20	M	6 weeks (2x a week / 55min)	1P 1K	agility	T-test, Illinois Agility Test, 4×9m shuttle run	improvement of **P** in all agility tests	**P** better improvement than **K**
Andrejić (2012)	21	12-13	M	6 weeks (2 x a week / 90min)	1S 1Ps	running 4x15m	strength training included *rubber cord exercises* and *body weight exercises*	**Ps** significant improvement in running 4 x 15m	**Ps** better results than **S**
Arazi, Coetzee & Asadi (2012)	18	18,81 ± 1,46	M	8 weeks (3x a week / 40 min)	1P 1Pv 1K	agility	/	improvement of **Pv** and **P** in the measured parameters	no difference between **Pv** and **P** in final measuring
Boccolini, Costa &	28	/	M	4 weeks (3x a	1K 1Knp	agility (lane	/	**Knp** improvemen	**K** did not have

Alberti (2012)				week / 20min)		agility drill test)		t of agility (3.07%)	improveme nt
Živković (2012)	23	14-16	M	6 weeks (3x a week)	1K 1Pro	agility	**Pro-** subjected to propriocepti ve training	**Pro** improvemen t of agility	/
Asadi (2013)	20	20.1 ± 1.3	M	6 weeks (2x a week	1P 1K	4×9m shuttle run, agility *T*-test and Illinois Agility Test	/	improvemen t of **P** in all tests	/
Mitra, Bandyopa dhyay & Gayen (2013)	60	18-23	M	8 weeks (3x a week / 45min)	1P 1K 1TS	agility *(Illinois Agility Test)*	**TS** –use of elastic strips, use of weights and use of partner's weight	improvemen t of agility at **P**	**P** better improveme nt than **K**, no difference between **TS** and **K**, and **P** and **TS**
Lehnert, Hůlka, Malý, Fohler & Zahálka (2013)	12	24,36 ± 3,9	M	4 weeks (2x a week) + 2 weeks (4x a week)	1P	agility	besides plyometric program, basketball players were still exposed to conditioning training	no significant difference of explosive strength and agility	/
Dadwal (2013)	40	18-25	F	10 weeks (3x a week / 40-50min)	1P 1K	agility	4x10m shuttle run	significant improvemen t of agility at **P** group	**P** significantl y better results than **K**
Komal & Singh (2013)	45	16-18	F	8 weeks	1P 1K 1T	agility	shuttle run test	**P** and **T** significantly better improvemen t than **K** in agility	/
Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014)	19	16.3± 0.5	M	8 weeks (2x a week)	1P 1Sp	2×5m shuttle run agility test and suicide run	both groups had basketball trainings during the experiment	at **P** and **Sp** improvemen t on the test suicide run	no difference between **P** and **Sp** at the end of treatment
Ramateert h & Kannur (2014)	21	12-13	M	6 weeks (2x a week / 90min)	1S 1Ps	running 4x15m	strength training included *rubber cord exercises* and *body weight exercises*	**Ps** improvemen t in all measured parameters	**Ps** better improveme nt than **S** in all measured parameters
Zarić (2014)	13	17.76 ±0.43	F	6 weeks	1E	agility	T-test	/	improveme nt in T - test (6.95%),

Ramachandran & Pradhan (2014)	30	20.4 ± 1.73	M F	2 weeks (3x a week)	1DiP	agility	10min-stretching, 30min-plyometrics, 10min-stretching	significant improvement of agility	/
Abraham (2015)	80	13-18	M	12 weeks (3x a week)	1P 1K 1Kt 1Bp	agility	/	improvement of **P**, **Kt** and **Bp** in agility	
McCormick at al. (2015)	14	high school	F	6 weeks	1Psr 1Pfr	agility	*lateral hop test* (left), *lateral hop test* (right), *lateral shuffle test* (left) and *lateral shuffle test* (right).	significant improvement of **Psr** and **Pfr** group in all tests	/
Ademović (2016)	15	18-26	M	12 weeks (3x a week/ 90min)	1Sk	agility	besides Sk training, basketball players had regular basketball trainings	significant improvement of all measured skills	/

Legend: **P**-group which underwent plyometric program; **K**-control group; **T**-group that underwent training with weights, **Ps**-group that was subjected to a combination of plyometric training and strength training (free of weights); **S**-group which underwent training with strength exercises (no weights); **TS**-group that underwent strength training which used exercises with weights and exercises without weights; **Sp**-group that underwent specific training of sprint; **Di**-group that was subjected to dynamic stretching; **DiP**-group that was subjected to a combination of dynamic stretching and plyometric exercises; **Kt**-group that was subjected to a circular training; **Bp**-group that was subjected to *circuit breaker* program; **Pv**-group that was subjected to water plyometric program; **Psr** group that performed plyometric jumps in the sagittal plane; **Pfr** group that performed plyometric jumps in the frontal plane; **Sk**-group that was subjected to SAQ training; **Knp**-group that was subjected to training jumps with a rope; **Pro**-group which was subjected to proprioceptive training; **E**-group in which the training process consisted of strength training, different types of endurance, basketball technique.

3. RESULTS

Classification of results

Most of the researches presented in Table 1 investigated:

- the effects of *plyometric training* on the agility of basketball players - 12 researches (Shaji & Isha, 2009; Chaudhary & Jhajharia, 2010; Shallaby, 2010; Bal, Kaur, Singh & Bal, 2011; Asadi & Arazi, 2012; Arazi, Coetzee & Asadi, 2012 ; Asadi, 2013; Mitra, Gayen & Bandyopadhyay, 2013; Lehnert, Hůlka, Malý, Fohler & Zahálka, 2013; Dadwal, 2013; Komal & Singh, 2013; Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel, 2014; Abraham , 2015; McCormick et al., 2015);
- *effects of the combination of plyometric training and any other training* on the agility of basketball players - **4** studies (Shaji & Isha, 2009; Andrejić, 2012; Ramateerth & Kannur, 2014; Ramachandran & Pradhan, 2014);
- the effects of *resistance training* (*without weights*) on the agility of basketball players - **2** studies (Andrejić, 2012; Ramateerth & Kannur, 2014);
- the effects of *dynamic stretching* on the agility of basketball players - **1** study (Shaji & Isha, 2009);
- the effects of *aquatic plyometric training* on the agility of basketball players - **1** study (Arazi, Coetzee & Asadi, 2012);

- the effects of *skipping rope* on the agility of basketball players - **1** study (Boccolini, Alberti & Costa, 2012);
- the effects of *proprioceptive training* on the agility of basketball players - **1** study (Živković, 2012);
- the effects of *strength training with and without weights* on the agility of basketball players - **1** research (Mitra, Gayen & Bandyopadhyay, 2013);
- the effects of *weight training* on the agility of basketball players - **1** study (Komal & Singh, 2013);
- the effects of the *training which consisted of strength training, different types of endurance and basketball technique,* on the agility of basketball players - **1** study (Zarić, 2014);
- the effects of *circuit breaker* program on the agility of basketball players - **1** research (Abraham, 2015);
- the effects of the *circular training* on the agility of basketball players - **1** research (Abraham, 2015);
- the effects of *SAQ training* on the agility of basketball players - **1** study (Ademović, 2015).

DISCUSSION

A great number of studies from Table 1 shows that the agility of basketball players can be developed with the help of plyometric training methods. Abraham (2015) on a sample of 80 respondents aged 13 to 18 years found that plyometric training for a period of 12 weeks (3x a week) leads to a significant progress of the agility of basketball players. Gottlieb, Eliakim, Shalom, Dello-Iacono & Meckel (2014) on a sample of 19 players, average age 16.3 ± 0.5 years found that plyometric training for a period of 8 weeks (2x per week) led to a significant progress on one of the two tests which evaluated agility. Mitra, Bandyopadhyay & Gayen (2013) on a sample of 60 players aged 18 to 23 years found that plyometric training for a period of 8 weeks (3 times a week / 45min) leads to significant improvements in the agility of basketball players. Asadi (2013) on a sample of 20 players, average age 20.1 ± 1.3 years found that plyometric training for a period of 6 weeks (2x per week) leads to significant progress agility basketball. Asadi & Arazi (2012) in a sample of 16 players aged 19 to 20 years found that plyometric training for a period of 6 weeks (2x per week / 55min) leads to significant improvements in agility. Arazi & Asadi (2012) in a sample of 18 players, average age 18.81 ± 1.46 years, found that plyometric training for a period of 8 weeks (3 times a week / 40 min) leads to significant improvements in agility. Bal, Kaur, Singh & Bal (2011) in a sample of 30 players aged 18 to 24 years found tha that plyometric training for a period of 6 weeks (2x per week / 25min) leads to a significant improvement of agility. Shallaby (2010) on a sample of 20 players aged 16 years found that plyometric training for a period of 12 weeks (3 times a week / 120min) leads to significant improvements in agility. Shaji & Isha (2009) in a sample of 45 players aged 18 to 25 years found that plyometric training of 4 weeks (2x a week) leads to significant improvements in agility. One of the rare studies in which plyometric training did not lead to significant improvements in the agility of basketball players is research by Lehnert, Hůlka, Malý, Fohler & Zahálka (2013). In their research, the experimental program lasted for six weeks (2x per week from the first to the fourth week of the program and 4x a week in the fifth and sixth week of the program). In addition to the plyometric program, the players were still exposed to the conditional training exercises that included speed training, aerobic endurance, resistance trainings and so on. It is possible that in this study, because of the volume of the program, the players entered a state of overtraining but there was no progress of the measured ability.

The researches also show that with the help of plyometric training, the agility of female basketball players can be developed. **McCormick et al. (2015)** on a sample of 14 high school

female basketball players found that plyometric training for a period of six weeks led to significant improvements in agility. **Ramachandran & Pradhan (2014)** in a sample of 30 female basketball players, average age 20.4 ± 1.73 found that a combination of plyometric training and dynamic stretching for 2 weeks (3 times a week) leads to significant improvements in agility. In this study the dynamic stretching was performed 10 minutes before and after the plyometric exercises which lasted 30 minutes. **Dadwal (2013)** on a sample of 40 female basketball players aged 18 to 25 years found that plyometric training for a period of 10 weeks (3 times a week / 40-50min) leads to significant improvements in agility. **Komal & Singh (2013)** in a sample of 45 female basketball players aged 16 to 18 years found that plyometric training for a period of 8 weeks significantly improves agility. **Chaudhary & Jhajharia (2010)** in a sample of 20 female basketball players aged 18 to 22 years found that plyometric training for a period of six weeks led to significant improvements in agility.

Any combination of plyometric training with other types of training can also be a good method for developing the agility of basketball players. **Ramateerth & Kannur (2014)** in a sample of 21 basketball players aged 12 to 13 years found that a combination of plyometric training and strength training (*rubber cord exercises* and *body weight exercises*) for a period of 6 weeks (2x per week) leads to a significant improvement in the high jump, long jump, medicine ball throw, sprint of 20m, running 4x15m and flexibility. The authors also found that this combination is more effective in developing the mentioned skills in relation to the strength training when used independently. **Andrejić (2012)** on a sample of 21 players aged 12-13 years found that the combination of plyometric training and strength training for a period of 6 weeks (2x per week) leads to a significant improvement in the high jump, long jump, running at 20m, running 4x15 and throwing the medicine ball. The author also found that the combination is more efficient in developing the mentioned skills in relation to the strength training when used independently. **Shaji & Isha (2009)** in a sample of 45 players aged 18 to 25 years found that a combination of dynamic stretching and plyometric exercises for 4 weeks (2x a week) leads to significant improvements in the vertical jump height and agility. The authors also concluded that the combination provides significantly more progress of the height of the vertical jump than when plyometric training and dynamic stretching are done separately. **Ramachandran & Pradhan (2014)** in a sample of 30 female basketball players, average age 20.4 ± 1.73 found that a combination of plyometric training and dynamic stretching for 2 weeks (3 times a week) leads to significant improvements in agility. In this study, the dynamic stretching is performed 10 minutes before and after the plyometric exercises which lasted 30 minutes.

In addition to plyometrics, other training methods can also develop the agility of basketball players. **Ademović (2015)** on a sample of 15 basketball players aged 18 to 26 years found that the SAQ training for a period of 12 weeks (3 times a week / 90min) can lead to a significant development of agility. **Zaric (2014)** on a sample of 13 female basketball players, average age 17.76 ± 0:43 years, found that a combination of strength training, endurance and basketball technique for a period of six months leads to a significant development of agility. **Živković (2012)** on a sample of 23 players, aged 14 to 16 years, found that the proprioceptive training for a period of 6 weeks (3 times a week) leads to a significant development of agility. **Boccolini, Costa & Alberti (2012)**, in a sample of 28 basketball players, found that training that involves skipping rope for a period of 4 weeks (3 times a week / 20min) can lead to a significant development of agility.

4. CONCLUSION

A review of the past researches shows that the plyometric training method is commonly used for the development of agility, in both male and female basketball players. This method of

training has proved to be extremely good for the development of this capability so we recommend it to conditioning coaches and basketball experts. However, when using this method of training, avoiding of overtraining and injuries of young basketball players should be taken into consideration. Before using the plyometric training methods, it is necessary to prepare the locomotor apparatus for such straining. It is advisable that before plyometric exercises, players have a basic preparation whose goal will be to develop stamina and muscle force. Several studies show that the agility of basketball players can be developed by a combination of plyometric training and any other training (dynamic stretching, strength training). Such an approach, in addition to the positive impact on the development of agility, can also have a psychological effect in the form of neutralizing the monotony and uniformity of training. View on the previous researches also shows that, in addition to plyometric training, the agility of basketball players can also be developed by other methods of training:
SAQ training;
- a combination of strength training, endurance training and basketball techniques;
-the proprioceptive training;
-rope jumping.
-preskakanje konopca.

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