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USE OF BALANCE EXERCISES FOR DYNAMIC STABILITY IN BASKETBALL INJURIES

UPORABA RAVNOTEŽNIH VAJ ZA DINAMIČNO STABILNOST PRI KOŠARKARSKIH POŠKODBAH

ABSTRACT

Basketball is a very popular team sport that is played around the world with a high prevalence of lower limb injuries. Therefore, we have decided to test the effect of balance exercises on the dynamic stability of the lower limbs. We performed dynamic balance testing on a 30-member group of young basketball players of the same average age, playing the cadet competition of the Slovak Championships - West Region. The control group consisted of 16 basketball players. For testing, we have chosen a test for the dynamic stability – Y balance test (YBT). Testing of the dynamic stability of the lower limbs with hands placed freely next to the body in the intervention group was statistically significant ($p < 0.05$). We have also noticed statistically significant improvement in the intervention group ($p<0.05$). Balance exercises have been associated with improved dynamic stability in young basketball players.

Keywords: Y balance test, dynamic stability, basketball, balance exercises

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IZVLEČEK

Košarka je zelo priljubljen moštveni šport celega sveta in je igra z visoko pojavnostjo poškodb spodnjih okončin. V pričujoči študiji smo se odločili preizkusiti učinek vaj ravnotežja na dinamično stabilnost spodnjih okončin. V vzorec smo zajeli 30 mladih košarkarjev podobne starosti. Izvedli smo testiranje dinamičnega ravnotežja na ekipi, ki je igrala kadetsko tekmo slovaškega državnega prvenstva - zahodna regija. Kontrolno skupino je sestavljalo 16 košarkarjev. Za testiranje smo izbrali test dinamične stabilnosti - preskus ravnotežja Y (YBT). Testiranje dinamične stabilnosti spodnjih okončin z rokami, ki so bile prosto nameščene ob telesu v intervencijski skupini, je bilo statistično značilno ($p < 0,05$). V intervencijski skupini smo opazili tudi statistično značilno izboljšanje ($p < 0,05$) dinamičnega ravnotežja. Ugotovili smo, da so vaje ravnotežja značilno povezane z izboljšano dinamično stabilnostjo mladih košarkarjev.

Ključne besede: Y ravnotežni test, dinamična stabilnost, košarka, ravnotežne vaje

INTRODUCTION

Basketball is a very popular team sport that is played all over the world. Nowadays, professional basketball has become a physical sport characterized by high dynamic activity (1) and intense body contact. The game is characterized by frequent interruptions, jumping, challenging one-on-one situations, rapid changes of direction combined with challenging technique and aspects of coordination such as catching, throwing, passing and dribbling (2). It is constantly evolving into a larger physical game in which body contacts are expected and accepted. Most injuries in basketball affect the lower limbs. Basketball requires a high level of motor skills and special skills (3), as well as a high level of movement control, muscle coordination, gentle differentiation, fast cooperation in combinations and many other factors (4,5). In addition, basketball develops a number of will skills, psychological resilience and social cohesion. Characteristic abilities for basketball are dribling, shooting, jumps, rebounds and defense. Game skills are interrupted by pauses when alternating or interrupting the game. Very typical for this sport is the fluctuating intensity of the load. The characteristic of muscular activity in basketball is dynamic, but sometimes there are also short-term static contractions. Kinematic analysis has shown that a player runs an average of 3500 to 4000 meters in a match, jumps 15 to 41 times, passes approximately 30 times, shoots 12 times, changes direction up to 640 times and speeds up to 440 times (6). This intesity is significantly modified considering the age, gender and performance.

According to Garbenytė - Apoinskene (2), the effectiveness of proprioceptive (neuromuscular) training in reducing the incidence of certain types of sports injuries among adolescents and young adult athletes during sports activities such as basketball, is high. Young experienced athletes must be trained carefully in order to avoid excessive stress that can affect them physically and mentally.

Musculoskeletal disorders are potential problem for basketball players (7,8,9,10). The main imbalances include core system (11,12). The incidence of injuries is much higher than in other non-contact sports. According to a retrospective analysis of data collected during the 17 seasons of the American National Basketball Association, most injuries affect the lower limbs (13). Neuromuscular asymmetry of the lower limbs is associated with high risk of injury (14). Asymmetries of the lower limbs in terms of strength, coordination and postural control, occur more in female athletes than in male athletes. The higher incidence of sportswomen’s injuries

is associated with neuromuscular factors, including the overall dominance of one leg over the other (15–17).

The main theory of balance exercises is to minimize the support base and to induce a state of "balancing", which leads to a coordinated engagement of muscle loops, and this ensures that we achieve targeted movements or maintain a relatively unstable position without developing maximum strength (18). During exercise on unstable platforms, a force acts on the articulation from several sides with a intensity constantly changing. Balance training specifically employs muscles in an agonistic-antagonistic position. The point is to create a situation in which an individual finds himself in a game situation or in everyday life.

Due to the high prevalence of injuries in basketball, we have decided to test the effect of balance exercises on improving dynamic stability.

The aim of the study was to create a unit of balance exercises, appply it in the training process and to verify the influence of balance exercises on the value of dynamic stability measured by the y balance test of basketball players.

H1: We assume that the impact of regular balance exercises will improve the dynamic stability of the intervention group of basketball players over a period of three months.

H2: We assume that after a period of 12 weeks, there will be no statistically significant changes in the final testing of the control group of basketball players compared to the initial testing.

H3: We assume a positive effect on the level of dynamic postural control in the final testing after completing the balance unit in the intervention group in comparison with the control group of basketball players.

METHODS

The main method of data processing was research, which includes monitoring the impact of the application of balance exercises. The intervention in the form of a balance program included exercises to prevent injuries and strengthen the core system muscles.

Example of one training unit focused on balance exercises realized in the intervention group of basketball players in Nitra

1. Female push ups with hands on a balance pad

2. Alternating jumps to the barefoot lunge

3. Dynamic plank with lower limb attraction

4. Squats on one lower limb holding the TRX

5. Support the kneeling on four

6. Side plank

7. Squats against the wall with a fit ball behind your back

8. Dynamic plank alternately from bent to protruding upper limbs

9. Bridge

10. Support on the barefoot with turning of the torso with medicimbal (kettlebell)

11. Pushing the fit ball

12. Strengthening the thigh muscles with a miniband around the ankles.

13. Exercises on the principle of dynamic neuromuscular stabilization

The sample characteristics

We performed dynamic balance testing on a 30-member group of young basketball players of approximately the same average age, who are involved in the cadet competition of the Slovak Championships - West Region. The control group consisted of 16 basketball players who play for a basketball club in Trnava. At the time of the research, this group did not participate in balance exercises aimed at injury prevention under our supervision. The intervention group consisted of 14 probands - players of the youth basketball team in Nitra. They performed the balance program under our supervision. We examined all the basketball players before the start of the training unit. The first testing of basketball players took place in September 2019 in the gym in Trnava while the second group test took place in Nitra sports hall. During the input and output measurements, we tried to maintain the same conditions. We carried out the final testing in both groups of basketball players after 3 months. Each player had their own form, where we recorded the obtained results of input and output measurements.

Table 1. Basic somatic characteristics of the control group of probands.

	Age	Height (cm)	Weight (kg)	BMI	Length Of limbs (cm)
Arithmetic average	14,30	167,90	61,90	22,00	89,10
Median	14,00	168,75	61,00	89,50	21,70
Modus	14,00	-	60,00	92,00	-
Direct. deviation	0,77	5,44	7,33	4,15	2,74

Table 2. Basic somatic characteristics of the intervention group of probands.

	Age	Height (cm)	Weight (kg)	BMI	Length of lower limbs (cm)
Arithmetic average	14,79	171,61	62,29	21,21	89,00
Median	15,00	169,00	61,50	20,44	88,50
Modus	14,00	167,00	55,00	23,03	92,00
Direct. deviation	0,80	6,36	8,57	2,75	4,47

Description of the intervention group

The research was carried out with 14 cadets aged 14 - 16 years in the sport hall from September 2019. The players train 4-5 times a week for 90 minutes. Last season, several players overcame more serious but also less serious injuries. Three players from the team had sprains of the right ankle joint, one of them also had a fracture of femur on the right lower limb. Furthermore, one player of the team had a fracture of calf bone in the left lower limb, another torn ligament in the right ankle joint and one of them distension of ligaments in the left knee. All players formed one intervention set, which we tested for 3 months. None of the players have not done balance exercises before this research. We exercise with the players twice a week before the training unit for 20-30 minutes. The balance exercise training was happening during the season from mid-September to the second half of December. Afterwards we carried the final testing.

Methods

The dynamic stability test chosen - Y balance test (YBT) - was used for testing. Input and output measurement took place at the beginning of training units so that basketball players were not tired and their performance was not affected by negative events from previous activities.

YBT is a simple but reliable test of dynamic postural control that requires athlete to balance on one leg with maximum reach of the opposite limb in three separate directions. Therefore, this test measures the strength, stability and balance of the athlete in different directions. It has been developed to standardize the modified Star Excursion Balance Test (SEBT), to improve its practicality, and even it has become a popular test. YBT is a measurement of dynamic balance and is used to assess performance, identify chronic instability of the ankles, and to identify athletes at higher risk of lower limb injury (14). The YBT consists of a standing platform on which three rods are slid in the anterior, posteromedial and posterolateral directions. The rear bars were located 135 degrees from the front bar and the angle between the rear bars was 45 degrees. The distance in centimeters is marked on the bars and the exact achieved distance is determined by a sliding indicator placed on the bars (19).

Description of testing by YBT

YBT was performed using a standardized test protocol that has proved to be reliable. Subjects were familiar with testing procedures. The tested player stands with one foot on the test pad with toes behind the red starting line. The other foot moves the pointer slid on the wooden stick as smoothly as possible in the three directions. The tested player starts testing on the dominant standing leg, the right and left legs reach the distance by three attempts in the forward direction (anterior) with the hands sideways and return to the starting position. After completing three successful attempts, player exchanges the standing leg for the left one and performs three valid attempts in the same direction with the right leg. As soon as the test subject makes three successful attempts, the procedure is also repeated in the following posteromedial and posterolateral direction with three attempts for each direction with the same leg placement order (20). The achieved distance should be recorded to the nearest 0.5 cm. The rest time between trials is approximately 20 seconds, which is the time to record data and return the pointer to its original position. After completing the test with the hands sideways, the tested person repeats the test with the hands free next to the body, while the test procedure remains the same. We have recorded the distance made by each valid attempt by the test player so that we could calculate the composite score YBT. In each test, the achieved distance has been recorded with

an accuracy of 0.5 cm, and the longest distance achieved from three valid trials in that direction has been used for analysis.

The test was performed in the following order:

1. Right anterior

2. Left anterior

3. Right posteromedial

4. Left posteromedial

5. Right posterolateral

6. Left posterolateral

Invalid attempt: the tested unit cannot touch the floor with his foot before returning to the starting position, as any loss of balance is considered an unsuccessful attempt. However, as soon as the test person returns to the starting position, can place his foot down behind the central test pad. Also, the player cannot place his foot on the range indicator to gain support during the attempt - he must push the range indicator with the red target area. The athlete must keep his foot in contact with the target pointer until he reaches the point. In order to achieve better performance, the foot must not be rested on or kicked.

Valid attempt: We evaluate the attempt when test person returns to the starting position without violating rules on the validity of the experiment.mentioned above.

After completing the test and recording all the performances of the test subjects, we have calculated the performance scores of the YBT athletes using the following equations or all of the following equations:

Composite score (%): (sum of three directions of reach) / (3 x limb length) x 100

The length of the limbs is measured from the spina iliaca of the superior anterior to the medial malleolus. The asymmetry achieved has been calculated by the absolute difference in the maximum range distance between the right and left side. We have suggested asymmetry greater than 4 cm during YBT has been proposed to predict which individuals are at risk of lower limb injury (21).

Statistical analysis

Based on the analytical functions of Microsoft Excel, testing with hands placed freely next to the body in the intervention group has shown to be statistically significant with a value of α - 0.05. Hypothesis H1 has been confirmed, therefore we assume that the impact of regular balance exercises in the intervention group of basketball players will improve the dynamic stability over a period of three months (Table 3). To verify the hypothesis, a parametric test has been selected - a two-sample t-test with equality of variances based on the F-test for variance.

RESULTS

Based on this, the established hypotheses could be confirmed or rejected. To confirm or to negate hypotheses, we have used a two-sample F-test for variance and a two-sample t-test with equality and inequality of variances. The test results have been processed using Microsoft Excel and SPSS statistics. We have used the arithmetic average, mode, median, min, max, variance and standard deviation. Subsequently, the YBT test results are compared from the input and output tests. The significance of the differences has been determined at the α -0.05 level of statistical significance.

Table 3. Composite scores of the intervention group with hands placed freely next to the body, significance of changes and statistical characteristics.

	n	***x̄***	***sd***	***x_m***	***mod(x)***	***max.***	***min.***	***p***	***t***
Right side input	14	98,77	5,86	98,84	100	109,74	89,77	0,0089	2,06
Right side output	14	101,35	6,89	101,8	-	116,3	90,04		
Left side input	14	99,41	6,65	99,81	-	109,47	87,06	0,0041	2,06
Left sidde output	14	104,06	5,93	103,92	-	115,93	91,95		

Legend: n – amount of probands, x̄ - arithmetic average, sd – directional deviation, xm - median, mod(x) - mode, max. – max. rate , min. – min. Rate, p – value of statistical significance, t – test standard.

F However, hypothesis H2 has been rejected, as we assumed that after a period of 12 weeks, there would be no statistically significant changes in the initial testing of the control group of basketball players compared to the initial testing (Table 4). A two-tailed t-test with equality of variances have been used.

Table 4. Composite scores of the control group with hands placed freely next to the body, significance of changes and statistical characteristics.

	n	$\bar{x}$	*sd*	x_m	*mod(x)*	*max.*	*min.*	*p*	*t*
Right side input	16	97	5,54	95,91	89,96	108,14	89,96	0,00044	2,04
Right side output	16	101,55	5,46	103,66	105,07	110,47	92,16		
Left side ínput	16	98,5	4,62	97,53	-	106,83	92,11	0,0020	2,05
Left side output	16	102,03	5,94	102,21	-	110,73	88,89		

Legend: n – amount of probands, x̄ - arithmetic average, sd – directional deviation, xm - median, mod(x) - mode, max. – max. rate , min. – min. Rate, p – value of statistical significance, t – test standard.

Comparison of intervention and control group

Table 5 Comparison of output testing composite score results with hands placed freely next to the body.

	Intervention group Right side	**Control group Right side**	**Intervention group Left side**	**Control group Left side**
Str. value	101,35	101,55	104,06	102,03
Spread	47,45	29,83	35,14	35,29
Observation	14	16	14	16
Common spread	38,01			
Hyp. difference of str. values	0		0	
Difference	28		27	
t Stat	-0,09		0,93	
p	0,93		0,36	
t	2,05		2,05	

Legend: t stat – test statistic value, p – importance statistic value, t – test standard.

We can see the difference between the final testing of the intervention and control group with hands placed freely, in the fact that we could not prove under the given conditions that it is statistically significant. We have used a two-tailed t-test with equality of variance for the right lower limb and with uneven variance for the left lower limb. Therefore, hypothesis H3 has been rejected. In comparison with the control group of basketball players we have assumed a positive

effect on the level of dynamic postural control in the final testing of the intervention group after completing the balance unit.

Table 6. Comparison of the composite score of the right lower limb.

Intervention group		
PDK	P	t
Input hands sideways Input hands free	0,03	2,06
Control group		
Input hands sideways Input hands free	0,03	2,05
Output hands sideways Output hands free	0,01	2,04

Legenda: p – importance statistic value, t – test standard.

In Table 4, the comparison of the initial/input measurement with the hands placed sideways and the hand handled freely to the right lower limb in the intervention and control groups has been statistically significant at the level of statistical significance α - 0.05. When comparing the output testing with the hands of the side and the free right lower limb, there has been statistically significant change in the intervention group but there has been no statistically significant changes when comparing the output of the control group with the hands placed sideways and free.

Table.7 Comparison of the composite score of the left lower limb.

Intervention group		
L'DK	p	t
Output hands sideways Output hands free	0,01	2,06
Control group		
Input hands sideways Input hands free	0,01	2,05
Output hands sideways Output hands free	0,01	2,04

Legenda: p – importance statistic value, t – test standard.

DISCUSSION

Performing successful basketball actions requires more than just physical skills, such as sprint, strength or ability to change direction but also dynamic stability or postural control. Postural control is important for specific sport exercises, and postural control deficits are associated with a higher risk of falls and injuries. There is a risk factor of injuries for young athletes, and changes in postural control may be related to the occurrence of ankle injuries in high school basketball players. In addition to ankle injuries, anterior cruciate ligament injuries are also common. According to Nessler (22), both professional and recreational athletes between the ages of 15 and 25 are at greatest risk of injury. Basketball is also one of the sports with a high risk of injuries, but a larger percentage of injuries are non-contact, and therefore we can eliminate them with a suitable prevention program included in training at a young age.

The main method of testing was the Y balance test in which we tested an intervention and control group of basketball players aged 13 to 16 years. According to Garbenytė - Apolinskienė (2), it is the age at which basic functional movement patterns are extremely important for athlete‘s development and injury prevention.

The aim of our study was to determine the effect of balance exercises as injury prevention on a selected group of basketball players. For testing of dynamic postural control and strength, we have chosen the Y balance test also used to identify athletes‘ risk of injury. After the initial testing, we have created balance exercises to prevent injuries and strengthen core system, which we then included in the 3 months training process. An intervention group of basketball players -2 times a week for 20-30 minutes before the training unit. First of all, we practised the correct stereotype of breathing in basketball players stabilizing function of the diaphragm through dynamic neuromuscular stabilization (DNS) techniques according to Kolář (23), we performed exercises according to the movement pattern in various basic and modified positions. Gradually, we have increased the difficulty of the exercise, we have supplemented and modified some exercises to avoid stereotypes and we have added more demanding balance aids. The players had been performing this exercise for 12 weeks under our supervision. None of the players regularly have done balance exercises before this research. Several players from the team have overcome several serious but also less serious injuries in the previous season. After performing the final testing, which we have carried out after less than three months, we can see from the tables and graphs that there has been an improvement in dynamic stability in the intervention group and during this period only 3 players out of a total of 14 basketball players

have overcome easier outbursts. The dynamic stability has also improved in the control group of basketball players, with whom we have not carried out a balance program. We could have probably expected better results after a longer period of application of the balance program, which are among the compensatory exercises.

Measurement took place in the gym and sport hall of the operating basketball teams. A selected intervention group of players has performed a program of balance exercises twice in a week before the actual training for three months under our supervision. The research has proved the confirmation of only one hypothesis, hypothesis H1. We have confirmed the improvement of dynamic stability due to regular balance exercises in the intervention group of basketball players over a period of three months. We have rejected hypothesis H2, as we have assumed that there would be no statistically significant changes in intervention and control group. This can also be explained by the effect of the training itself on the y balance test values. Concerning the difference between the output testing of the intervention and control group with hands placed freely under the given conditions, we could not prove that it is statistically significant, and therefore we have rejected hypothesis H3, where we have assumed a positive effect on the level of dynamic postural control in output testing after the balance unit in intervention group compared to the control group of basketball players. Although the comparison of the intervention and control groups have not proved to be statistically significant, nevertheless, by analyzing the values obtained and the results obtained, we have proved that the balance exercise has an effect on improving dynamic stability and strength. Because when comparing the results of input and output testing, we can state that after the application of the intervention program of balance exercises, there has been an improvement in dynamic stability. Most of the players in the intervention group have experienced positive changes after completing the exercise. We are aware that success and technical level of dynamic are influenced by several factors and the possibility of including balance exercises in training is wide.

The results of a study by Boccolini (24) have shown that performing a 30-minute balance training twice a week for 12 weeks causes a significant improvement in early balance and vertical jump, both in the bipedal and monopedal positions. For this reason, in addition to being a valid training procedure for preventing injuries in basketball, balance training using unstable surfaces is an effective training method to improve dynamic stability and vertical jump. According to Boccolini et al. it is a very effective training method that every basketball coach should consider.

CONCLUSION

Balance exercises for basketball players have been linked with improved dynamic stability for young basketball players.

Declaration of Conflicting Interests

The authors declare that they have no conflict of interest.

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