THE IMPACT OF INTRODUCING A LIGHTER AND REDUCED-DIAMETER BASKETBALL ON SHOT PERFORMANCE IN YOUNG FEMALE BASKETBALL PLAYERS

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Abstract:

The study investigated the effects of the introduction of a basketball used by women to the Fédération Internationale de Basketball (FIBA) rules in the 2004/5 season to improve the efficiency and accuracy of basketball shooting. The main purpose was to establish whether the introduction of a reduced-diameter and lighter basketball (size 6) affects the efficacy and number of shots by female basketball players aged 15 and 16 (cadet age category). The sample included 576 European female basketball players who were members of national teams at the cadet Women's European Championships in 2001, 2003, 2005 and 2007. The players were classified into three subsamples according to their playing positions: guards, forwards and centres. It was found that statistically significant differences by year (tournament) occurred only in terms of the percentage of scored free throws. The percentage was lower in 2005, whereas in 2007 it was higher than in the reference year of 2001. In the same year (tournament), the number of two-point shots taken and the shots scored by the guards increased, whereas in the case of the centres, it decreased. Contrary to the expectations, the results showed that the introduction of a new basketball (size 6) did not cause any important improvement in the shooting efficacy of young female basketball players (free throws being the only exception) and also that the number of three-point shots taken did not increase.

Key words: *cadet women, size 6 basketball, playing efficiency*

Introduction

Many factors affect sporting performance. They include individual abilities of athletes and the equipment they use (Pitts & Semenick, 1988). A change in the size and weight of the equipment and in the material they are made of can affect skill performance and techniques (Pitts, 1985). Concern about modifying rules and game conditions has grown in the last two decades (Arias, Argudo, & Alonso, 2011). In many sports, the rules have been changed and the equipment modified due to differences in terms of age, gender, anthropometric measures, physical and psychological development, motor learning and acquisition of new skills, preventing injuries, but also due to ever greater commercial pressure (Pitts, 1985; Arias, et al., 2011). Some of these changes have been less and others more significant and important for athletic performance. Arias et al. (2011) reported that there were many studies about rule modifications in sport. The studies mostly referred to the aims of their analysis. They have also found that 80% of the studies do not report the outcomes of the previous modifications they analysed and about 60% of the studies achieved the proposed aims. According to Arias et al. (2011), the modifications related to the internal logic rules (structural and functional) have the greater likelihood to achieve goals for which rules have been modified.

The gender differences in terms of body height and mass are well known. They are relatively small at young age and become apparent after puberty (Cumming, Standage, Gillison, & Malina, 2008). The most obvious and important gender-related difference in terms of performance in sport is the ratio between strength and body mass, which, after puberty, skews in favour of men (DeVries, 1986). Strength is an extremely important attribute for shooting efficacy (Carroll, Carson, & Riek, 2001; Justin, Strojnik, & Šarabon, 2006; Sherwood, Schmidt, & Walter, 1988; Tang & Shung, 2005; Trninić, 2000), especially for the shots taken from the perimeter. Therefore, any changes in ball mass can influence shooting skills/techniques and, consequently, also the accuracy of shooting.

The standard size of the basketball (size 7) is not a result of research findings. This size was determined by a manufacturer (Pitts, 1985). Already in

the 1930s the first ideas emerged that women should play basketball with a smaller and lighter ball (Pitts & Semenick, 1988). This new ball (size 6) design appeared first in the USA in 1978 in the Women's Basketball League (WBL) (Cottrell, 2012). The difference between ball sizes 6 and 7 is 34 mm in circumference, 10.8 mm in diameter and 70 g in mass, all in the middle of the range interval. In Europe, this change was only adopted on June, 12 2004 when Fédération Internationale de Basketball Associations (FIBA) amended the Official Basketball Rules. Accordingly, the 2004/5 season is the first in which women in all age categories and all competitions under the auspices of FIBA played with a smaller and lighter basketballs, namely, the size 6 balls (Fédération Internationale de Basketball Associations, 2012).

Accordingly, the introduction of the size 6 basketballs resulted in a changed ratio between the ball and rim diameters. The minimum entry angle (angle of incidence) at which the ball still passes through the rim decreased by 1.62° (Podmenik, Leskošek, & Erčulj, 2012). The theoretical conclusion that it is easier to score with a size 6 basketball (a smaller and lighter ball) and that, consequently, shooting performance would be higher, is therefore logical. Such expectation can be underpinned by the results of the study by Khlifa, Aouadi, and Gabbett (2013) establishing the effects of a shot training programme using a reduced rim diameter with a standard size basketball. They found that training with a reduced rim significantly improved the free-throw performances of young basketball players. Rendell, Farrow, Masters, and Plummer (2011) reported that pre- and post-testing of shooting performance in netball revealed a change in the maximum ball trajectory height and they recommended increasing the trajectory of shots with a 0.3 m high metal barrier.

The size 6 basketball has been introduced for female basketball players because of the gender differences in terms of body height, body mass, arm length and strength of the upper body. The aim was to encourage female basketball players to decide to shoot from wider shooting ranges more often and to improve their shooting efficacy (Porter, 2006). Despite these many important reasons for introducing smaller and lighter basketballs for female basketball players in Europe, there is a lack of research aiming to establish the effects of the size 6 basketball on performance of young athletes (players).

In their study Podmenik et al. (2012) could not find any important improvement in the shooting efficacy of adult players after the introduction of a new basketball used by women in the 2004/5 season. However, no study analyses the effects of a new basketball on shooting efficacy of younger players. It would be logical to expect that this would be more important for younger and weaker (in terms of muscular strength) female basketball players than for their older and stronger counterparts. Their shooting efficiency may be improved with a new (lighter and smaller) ball so they may take large-distance shots at the basket more often. As these were also the expectations of FIBA, which introduced the new ball into its women's basketball competitions, we believe it is important to check whether these expectations have also been met and whether the introduction of the new ball was justified. Therefore, the aim of our study was to investigate whether the introduction of a smaller and lighter ball has affected cadet (U16) female basketball players' shooting efficacy and the number of perimeter shots taken, especially those from large distances (three-point attempts).

Methods

Subjects

The sample included all female basketball players who were members of national teams that had qualified for the Women's European Championships for cadets (ECs) in 2001 (Bulgaria), 2003 (Turkey), 2005 (Poland) and 2007 (Latvia). The players were 16 years of age or younger. The participants of the 2001 and 2003 ECs used a size 7 basketball, while those in the 2005 and 2007 ECs used a size 6 basketball. The participants of the 2005 EC have practised for about one year with a size 6 basketball and the participants of the 2007 EC have practised for about three years with a size 6 basketball. Twelve teams participated in the 2001 and 2003 ECs and 16 teams in the 2005 and 2007 ECs. The study included all teams playing in the 2001 and 2003 ECs and the best 12 teams playing in the 2005 and 2007 ECs. Based on this criterion, the 12 best European national teams from all ECs were included in the sample. The number of matches played at the 2001 and 2003 ECs with a size 7 basketball was the same as in the 2005 and 2007 ECs in which a size 6 basketball was used. As the matches can also include overtime periods, the difference in the absolute playing time between the ECs in which the same basketball size was used was 1%, whereas the difference between basketball sizes 6 and 7 was 4% of the playing time.

The players were divided into three basic playing positions: guards (point guard, shooting guard), forwards (small forward, power forward) and centres. At the 2001 EC, 23% of all players did not have a specific playing position, whereas at the 2003 EC, the respective figure was 10%. At the 2005 and 2007 ECs, all players were assigned to a specific position.

Procedures

The data were acquired from FIBA's official website (www.fiba.com), where the official basketball statistics are published for all of the previously mentioned European Championships. The analysis of the statistical data on an individual game by playing position encompassed the following variables: percentage of two-point shots scored, percentage of three-point shots scored, percentage of free throws scored, number of two-point shots taken, number of three-point shots taken, number of free throws taken, number of two-point shots scored, number of three-point shots scored and number of free throws scored. We wanted to avoid the extreme values in terms of the percentage of scors by playing position. Therefore, the analysis only included those players who took a one-, two- or three-point shot at the basket at least five times. Thus, 81.8% of all players were included for the two-point shot, 47.9% for the three-point shot and 65.8% for free throws.

Statistical analysis

The data were analysed using the PASW Statistics 18.0.3 and Microsoft Excel software. The results were presented with descriptive statistics and diagrams. Binary logistic regression with the outcome of each attempt (scored, missed) as the response variable, year of tournament (and hence, size of a ball) as fixed factors, and player as a random factor was performed in R 2.14.2 using the glmmPQL function of the MASS library.

Results

During the ECs, the number of two-point attempts increased slightly in terms of playing time after the introduction of the size 6 basketball. The 2003 EC, in which the size 7 basketball was used, deviates considerably from other ECs in terms of the number of shots at the basket. The number of two-point shots taken and free throws taken was smaller than in other ECs, whereas the number of three-point shots taken was higher. In the same year, the percentage of three-point shots scored was the highest even if a size 7 basketball was used. The highest number of free throws taken was recorded in 2001, whereas the percentage of free throws scored was the highest in 2007. The percentage of two-point shots scored stayed approximately the same in all ECs (Figure 1).

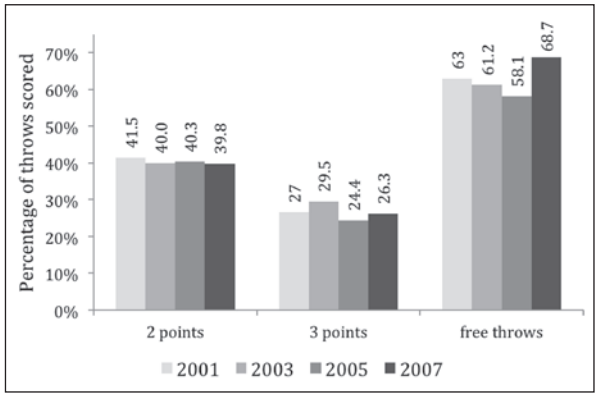

Figure 1. Percentage of shots scored, by EC.

Table 1. Average values of shots and points scored by playing positions

Position	year	2 points		3 points		Free throws	
		Shots taken	Shots scored	Shots taken	Shots scored	Shots taken	Shots scored
Guard	2001	26.2	9.8	16.0	4.0	16.3	10.4
	2003	28.6	10.9	23.9	7.0	12.5	7.6
	2005	32.9	12.8	18.2	4.5	14.9	8.6
	2007	32.3	11.6	17.2	4.4	13.1	8.5
Forward	2001	33.5	14.0	11.8	3.3	17.5	11.9
	2003	32.5	13.0	10.6	3.3	14.1	8.5
	2005	33.7	13.3	11.1	2.7	15.1	8.9
	2007	35.4	14.5	10.9	3.0	15.8	11.4
Centre	2001	41.6	18.9	1.0	0.3	22.5	12.6
	2003	34.8	15.2	1.5	0.3	14.4	9.1
	2005	33.6	14.7	1.0	0.2	16.1	9.1
	2007	30.0	13.4	1.4	0.2	12.6	8.6
(Unknown)	2001	19.8	7.4	5.7	1.6	11.0	7.2
	2003	8.6	2.1	3.3	0.5	4.0	2.5
Total	2001	30.7	12.7	8.8	2.3	16.9	10.7
	2003	29.5	11.8	12.0	3.5	12.7	7.8
	2005	33.4	13.4	11.3	2.8	15.2	8.9
	2007	32.9	13.1	11.1	2.9	14.0	9.6

The average number of two-point shots taken by the centres decreased with years (from 41.6 to 30), whereas the forwards recorded similar values throughout the years (Table 1). With the guards, the number of two-point shots taken increased after the introduction of the size 6 basketball. The guards took the highest number of three-point shots in 2003 (when the basketball size was 7), whereas the forwards maintained the same number throughout all ECs. In general, the centres decided to take a three-point shot on a very few occasions. The values for free throws are similar within the years, yet it should be noted that the highest number of free throws taken was recorded at the 2001 EC (with the size 7 basketball) – in all groups of players. At the 2001 EC, the centres made on average 22.5 free throws per match. The players with an undetermined playing position executed fewer shots of all types and their shooting was less accurate.

At all ECs, the highest percentage of two-point shots was scored by the centres, followed by the forwards and guards (Figure 2). The percentage of two-point shots scored did not change substantially between the ECs in any of the playing positions. The same applies to the total percentage of two-point shots scored, which was approximately 40% at all ECs (Figure 1). The percentage of three-point shots scored was the lowest in 2005 when the smaller and lighter basketball was introduced. When the size 7 basketball was used, the highest percentage was recorded by the forwards, whereas after the introduction of the new basketball, the percentage of three-point shots scored by the guards and the forwards was the same. In 2007, the percentage of three-point shots scored rose again. The centres can be disregarded in the analysis of this shot since, throughout the years, only 10 players met the criterion of shooting at the basket at least five times from the perimeter. Regarding the free throws scored, it can be established that the percentage of the attempts scored gradually decreased in the first three ECs and reached a minimum at the 2005 EC, which is the first championship in which a size 6 basketball was used. This applies to the guards and the forwards, as well as to the total value. The decrease in the share of free throws scored is particularly evident with the forwards as it dropped by as much as 12.5% between 2001 and 2005. At the 2007 EC, the percentage increased again for all playing positions, exceeding even the value recorded at the 2001 EC. Moreover, a binary logistic regression (Table 2) proves that the scoring percentage in 2005 was statistically significantly lower than in the reference year of 2001, whereas in 2007 it was statistically significantly higher.

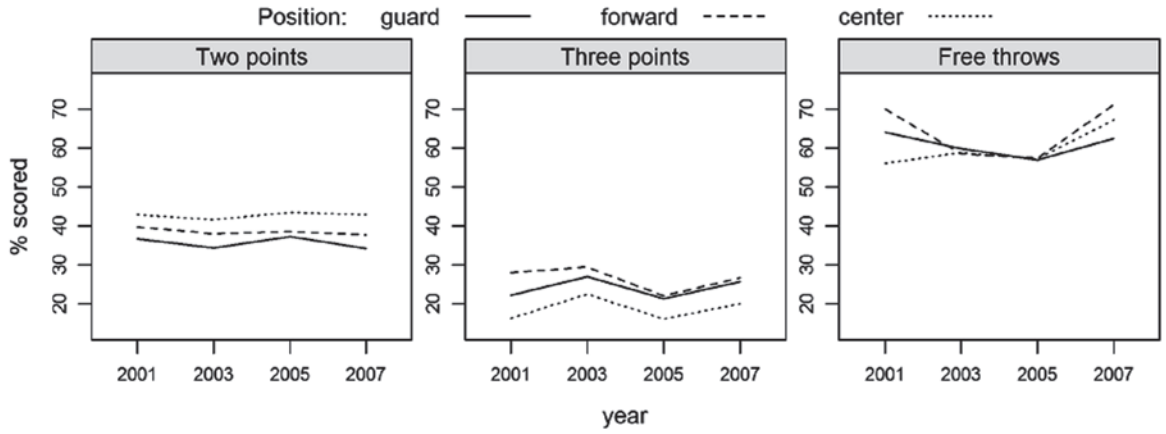

Figure 2. Average percentage of one-, two- and three-point shots scored by playing positions for players who took shots from a specific position at least five times.

Table 2. Results of binary logistic regression with year of tournament as fixed factors, players as random factor and success of shot as response***

	Adjusted ratio (95% confidence interval)		
	Two-point shots	Three-point shots	Free throws
Year: 2003	0.94 (0.84-1.04)	1.14 (0.96-1.35)	0.91 (0.77-1.07)
Year: 2005	0.96 (0.86-1.06)	0.88 (0.73-1.04)	**0.81 (0.70-0.95)*****
Year: 2007	0.93 (0.83-1.03)	0.98 (0.83-1.17)	**1.23 (1.05-1.45)*****

* - The reference year (tournament) is 2001
** - The outcome variable was a shot taken: 1-successful, 0-unsuccessful
*** - significant at α=5%

Discussion and conclusions

Statistically significant differences by year (tournament) occurred only in terms of the percentage of free throws scored. The percentage was lower in 2005, whereas in 2007 it was higher than in the reference year of 2001. In the same year (tournament), the number of two-point shots taken and scored by the guards increased, whereas in the case of the centres, it decreased.

There are no substantial differences when comparing the percentage of three-point attempts with the old and new basketballs. The lowest values were recorded at the 2005 EC. This was the first EC after the introduction of the new basketball. Therefore, a slightly lower percentage during this EC can most likely be ascribed to the players' problems with adapting to the new, smaller and lighter ball. When analysing the three-point attempts, the figures pertaining to the centres must be explained with caution because the centres very rarely decide to shoot from such a distance. The number of shots scored by the guards and the forwards practically did not change. The only exception with the guards occurred in the 2003 EC, at which the number of shots scored was substantially higher than at other ECs. This exception occurred in 2003 and cannot be ascribed to the introduction of the new basketball. The results of this study were different than anticipated as it was expected that young female basketball players would have taken shots more frequently from a large distance (perimeter) with the smaller and lighter basketball. Namely, the new basketball ought to be much more appropriate for the abilities and characteristics of basketball players that influence the execution and efficiency of shooting from a wide range (maximum and explosive strength of the arms, speed of the ball release and length of the arms). As these dimensions of young female basketball players are less developed than those of their older counterparts (Delextrat & Cohen, 2009; Erčulj & Bračič, 2010b; Erčulj, Blas, & Bračič, 2010), it was assumed that the new basketball would have an even stronger influence on the number of three-point attempts, inspiring young players to take a three-point shot more often than before. The ratios of three-point shots scored were also contrary to our expectations. In 2005 (the first EC in which a size 6 basketball was used), the percentages were the lowest across all playing positions, whereas at the next EC (2007) the values were closer to those recorded at the 2001 EC. It can be concluded that the change in the size and weight of the basketball did not affect the efficacy of shots from the perimeter.

The percentage of two-point shots scored stayed approximately the same at all ECs, which is clearly evident from the binary logistic regression (Table 2). Thus, with the introduction of a size 6 basketball, the shooting efficacy did not increase in any playing position. The centres recorded the highest percentage across all the observed ECs. This could be expected considering the position of the centres in offence, as they most frequently take close-range shots (from under the basket). These shots are generally easier to score than the long-range shots. It is interesting that on avarage the centres took two-point shots ever more rarely through the years. The difference between the 2001 and 2007 ECs in two-point attempts is as many as 12 shots fewer per match. The difference might have been explained by the higher number of three-point shots taken, but because this was not the case (the number of three-point shots scored did not increase when the new basketball was used) (see Tables 1 and 2), this can only be explained by the changed role of the centres in play, or by poorer quality of the players in this position. Conversely, players in the position of guards took a two-point shot more often after the size 6 basketball had been introduced. Given the differences between the centres and guards in terms of anthropometric characteristics and certain motor abilities (Erčulj, Blas, Čoh, & Bračič, 2009; Delextrat & Cohen, 2009; Erčulj & Bračič, 2010a; Erčulj & Bračič, 2010b; Erčulj, et al., 2010; Norton & Olds, 2004; Trninić, 2000), we might have been able to conclude that the smaller and lighter basketball is more suitable for the guards and that these players, once the new basketball size is used, will decide more often to execute the long-range shots, which subsequently means that they will perform two-point shots more rarely. However, as mentioned before, the study results do not confirm this supposition. The results provide grounds for a theory that the introduction of a smaller ball contributed to higher self-assurance of the guards in the sense that they dribble and control the ball better. Consequently, the number of their dribble penetrations and two-point shots is increased. Regrettably, the statistics of the play taken during basketball matches does not enable the identification of such elements of basketball play, which is why this theory cannot be verified.

A basketball free throw is not a defended shot and is always executed from the same distance (4.6 metres) in relatively controlled and stable conditions. Therefore, the efficacy of this shot is not influenced by so many factors as field shots are (Podmenik, et al., 2012). For this reason we believe that this type of shot indicates most directly the effect of introducing the size 6 basketball on the efficacy of shooting at the basket. The current findings show that the introduction of the size 6 basketball resulted in a statistically significant decrease in the percentage of free throws scored in 2005 as compared with the year 2001, and not in an increase, as had been expected. There are some contradictions in the studies about changing the basketball size and the shooting technique in children.

Arias (2012) reported significant changes in shooting technique and also an improvement in shooting accuracy and efficacy. The latter were higher with the 440 g ball in comparison with the regular ball (485 g) and the 540 g ball. On the other hand, Okazaki and Rodacki (2005) established that neither the weight nor the size of the basketball affected the coordination or shooting technique. The effect of the weight and size of the ball has only a minor effect on jump-shooting coordination. A consistent pattern of movement that may not be easily changed in a short period of practice was proposed to explain such coordination pattern stability. Both mentioned studies involved younger age groups (9- to 11-year-old boys). It is possible that the participants in our study (cadet female players) experienced some problems with coordination when executing free throws. This might be related to adaptation to the smaller and lighter basketball, especially at the first EC played with the new basketball. The 2005 EC participants had only one year of experience and practice with the size 6 basketball. It should be noted though that the free-throw percentage rose again in 2007 and was statistically significantly highest compared with other ECs. It must be considered that the cadet category has limited time to practice basketball. Thus, the players who participated in the 2007 EC were 13 years of age or younger at the time the size 6 basketball was introduced. This indicates that most players participating in the previously mentioned EC had little experience with a size 7 basketball and they had already been practising with a size 6 basketball for three years, so their adaptation to the smaller and lighter ball was very good. It is not easy to explain a large number of free throws (taken and scored) at the 2001 EC and a low number at the 2003 EC with the same basketball (see Table 1). The number of free throws can also be ascribed to different playing tactics or more frequent violations of the rules (personal fouls committed) and perhaps also to the referees' stricter criteria for calling personal fouls. However, this is a complex problem and it certainly needs to be studied in the future.

Given the anthropometric characteristics of the male and female body – primarily the gender-related difference in strength – the introduction of a smaller and lighter basketball is an understandable and expected change of basketball rules. However, it was established that the introduction of a smaller and lighter basketball did not cause any improvement in the shooting efficacy of adult female players (it was even decreased in the case of free throws), although the number of three-point attempts increased (Podmenik, et al., 2012). The same trend for the cadet players cannot be confirmed. It seems that, contrary to adult players, free throw percentage increases with cadet players.

Nevertheless, when considering all results it cannot be confirmed that the introduction of a smaller and lighter basketball did cause any important and relevant improvements in the shooting efficacy of young players. It may be concluded that shooting efficacy is a very complex issue. It depends on a large number of factors (Rojas, Cepero, Onä, & Gutierrez, 2000; Satti, 2004) most of which cannot be controlled during the game. Despite the findings demonstrating clearly that, in general, the new basketball did not improve the shooting efficacy or increase the number of three-point shots scored, it should not be overlooked that the size of the ball can affect other basketball elements such as dribbling, passing, pass reception. It has already been established that 9- to 11-year-old male basketball players executed more dribbles, passes, pass receptions and also one-on-one situations with the 440 g ball when compared to the regular (485 g) and 540 g ball (Arias, Argudo, & Alonso, 2012a; 2012b). It would therefore be interesting to investigate the effects of the new ball on the previously mentioned skill elements performed by different age groups of female basketball players and to analyse the performance of shooting during the European Championships after 2007.

The findings of this study suggest that the introduction of the new ball for young female basketball players may not have been fully justified and reasonable. In the future, such important modifications of the rules should be based on research findings and verified in practice. We can only agree with Arias et al. (2011) that modifications that are to be introduced in any sport should be analysed through a reflective process before they are finally implemented.

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UTJECAJ UVOĐENJA LAKŠE KOŠARKAŠKE LOPTE MANJEG DIJAMETRA NA IZVEDBU ŠUTA MLADIH KOŠARKAŠICA

Istraživanje je bilo usmjereno na učinke uvođenja drugačije lopte u pravila Međunarodne košarkaške federacije (FIBA) u sezoni 2004./2005. na poboljšanje učinkovitosti i preciznosti šuterskih performansi mladih košarkašica. Glavni je cilj istraživanja bio utvrditi utječe li uvođenje lakše i manje lopte (veličina 6) na učinkovitost i broj bacanja na koš u košarkašica dobi od 15 i 16 godina (kadetski uzrast). Uzorak ispitanica je uključivao 576 europskih košarkašica koje su bile članice nacionalnih selekcija na ženskim kadetskim Europskim prvenstvima održanima 2001., 2003., 2005. i 2007. godine. Igračice su bile podijeljene u tri poduzorka prema igračkim pozicijama: braniči, krila i centri. Utvrđena je statistički značajna razlika u postotku uspješnih slobodnih bacanja između godina (održavanja turnira). Postotak je bio manji 2005. godine, dok je 2007. bio veći nego u referentnoj 2001. godini. U istoj godini (turnir) se povećao broj koševa za dva poena te broj koševa koje su postigli braniči, dok se smanjio za centre. Suprotno očekivanjima, rezultati su pokazali da uvođenje nove košarkaške lopte (veličina 6) nije prouzročilo nikakvo značajno poboljšanje šuterske učinkovitosti mladih košarkašica (jedina iznimka bila su slobodna bacanja) te također nije uzrokovalo povećanje broja bacanja za tri poena.

Ključne riječi: *kadetkinje, košarkaška lopte veličine 6, igračka učinkovitost*

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