Original Article

Difference-based analysis of the impact of observed game parameters on the final score at the FIBA Eurobasket Women 2019

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ABSTRACT

Evaluation in women's basketball is keeping up with developments in evaluation in men's basketball, and although the number of studies in women's basketball has seen a positive trend in the past decade, it is still at a low level. This paper observed 38 games and sixteen variables of standard efficiency during the FIBA EuroBasket Women 2019. Two regression models were obtained, a set of relative percentage and relative rating variables, which are used in the NBA league, where the dependent variable was the number of points scored. The obtained results show that in the first model, the difference between winning and losing teams was made by three variables: true shooting percentage, turnover percentage of inefficiency and efficiency percentage of defensive rebounds, which explain 97.3%, while for the second model, the distinguishing variables was offensive efficiency, explaining for 96.1% of the observed phenomenon. There is a continuity of the obtained results with the previous championship, played in 2017. Of all the technical elements of basketball, it is still the shots made, assists and defensive rebounds that have the most significant impact on the final score in European women's basketball. It can be noted that, unlike with the previous championship, inside play is no longer dominant, but there is a balance between inside and outside play, which has already been established as a developing trend in men's basketball. The emergence of the offensive efficiency variable indicates that it is becoming significant in top-tier competitions as well but is still a challenge for coaches to grasp the causes of this multicomplex issue based on this indicator.
Keywords: Defensive rebound; Field goals made; Offensive efficiency; Regression models; Turn overs; Women's basketball.

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INTRODUCTION

Basketball is, in the scope of scientific research, one of the most analysed sports (Mikołajec et al., 2013) because after each game a box score is made available, which "*provides for each player and each team, quantitative information on 15 variables*" (Celeux and Robert, 2015, p. 51). In the words of Víctor Blanco, Román Salmerón and Samuel Gómez-Haro: "*One of the main differences between basketball teams and other sports comes from the availability of information*" (2018, p. 2). For that reason, it is important to revisit them to expand our knowledge on the situational conditions that affect performance (Gómez et al., 2013). Despite that, it is a fact that scientific literature on women's basketball is still limited (Conte et al., 2015; Kreivyte et al., 2013; Milanović et al., 2016), although "*women's basketball analysis through game-related statistics would seem to be an important area of research*" (Gómez et al., 2009, p. 278), even though the evolution of women's basketball has not been falling behind men's basketball. This is corroborated by the fact that a mere 15 months after the first experimental basketball match was played between two classes at Springfield YMCA (21 December 1891), Senda Berenson Abbott organized the first ever match between women's teams in this sport at Smith College, Northampton, Massachusetts, on 22 March 1893 (Simović and Pavlović, 2013). It must be said, though, that in the past decade the trend has been shifting and numerous papers have been published on this topic (Bazanov and Rannama, 2015; Conte and Lukonaitiene, 2018; Dimitros et al., 2013; Fylaktakidou et al., 2011, 2013; Gómez et al., 2013; Koon et al., 2011; Kreivyte et al., 2013; Leicht et al. 2017; Madarame 2018a, 2018b, 2018c, 2018d; Milanović et al., 2016; Moreno et al. 2013; Șentuna et al., 2018; Simović et al., 2017; Veleirinho and Tavares, 2013).

The performance indicators have often been the subject of research in basketball (Kioumourtzoglou et al., 1998). Two most common approaches in the scientific study of performance in basketball are biomechanical and notational analysis (Gréhaigne et al., 1997; Hughes and Bartlett, 2002). In notational analysis, which carries a long tradition in basketball, going back to 1930s and early 1940s, when a series of papers were published, including women's basketball as well (Messersmith et al., 1940; Miner et al., 1940), using game-related data, technique and tactical skills, providing information on the technical, tactical, physiological and psychological demands of basketball (Huges and Franks, 2004). Today, notational analysis is deemed to be an objective method of quantifying key elements of performance in a valid and consistent way (Nevill et al., 2008).

Performance analysis focuses on players and game evaluation in an attempt to get better insight into the aspects that allow for the optimization of player and team resources, but also to identify competition demands (Barris & Button, 2008), its main purpose being to provide useful information to adapt the training process (Ribas et al., 2011), because "*contest performance indicators analysis of the best European basketball teams provides a lot of objective information about the game of basketball, its development and the achieved results*" (Kreivyte et al., 2013, p. 46).

A study by Anna Volossovitch classifies research topics for notational analysis into the following areas: shooting performance analysis, individual and team performance analyses using game-related statistics, scoring dynamics, dynamic analysis of space-time coordination and interactions between players and teams and competitive activity profiles and specific position demands (Volossovitch, 2017). In statistical research, discriminant analysis is often used to identify the game-related statistics which discriminate between winning and losing teams in a league or tournament (Sampaio et al., 2013).

The aim of this paper is to ascertain if the difference in points scored between the winning and losing teams is a function of the differences in quantitatively observed relative indicators of situational analysis in basketball during the last continental championships – the FIBA EuroBasket Women 2019.

METHODS

The sample of entities in this paper consisted of games (*n* = 38) played during the FIBA EuroBasket Women 2019. The championship was played from June 27 to July 7 in Latvia and Serbia in four cities: Belgrade, Riga, Zrenjanin and Niš. The championship included 16 national teams that qualified for the final tournament: Belgium, Belarus, Montenegro, the Czech Republic, France, Italy, Latvia, Hungary, Russia, Slovenia, Serbia, Spain, Sweden, Turkey, Ukraine and Great Britain.

For the purposes of this paper, two models were formed with absolute values obtained based on the 13 manifest variables gathered during matches in a manner prescribed by rules of the International Basketball Federation, provided at the official IBF website, http://www.archive.fiba: PST – total points, A2 – 2 points attempted, M2 – 2 points made, A3 – 3 points attempted, M3 – 3 points made, AFG – field goals attempted, MFG – field goals made, AFT – free throws attempted, MFT – free throws made, OR – offensive rebounds, DR – defensive rebounds, TOTR – total rebounds, AS – assists, PF – personal fouls, TO – turnovers, ST – steals, and BS – blocked shots.

Various formulas were used in scientific literature to calculate relative variables of the standardly observed parameters of the game of basketball, and this paper used absolute variables which are used in the NBA league: 2% – percentage two points (M2/A2)*100, 3% – percentage three points (M3/A3)*100, FG% – percentage field goals (MFG/AFG)*100, FT% – percentage free throws (MFT/AFT)*100, eFG% – effective field goal percentage [FGM + (0.5 x 3PTM) / FGA]*100, TS% – true shooting percentage [2 * (FGA + 0.475 * FTA)]*100, OR% – efficiency percentage of offensive rebounds [ORB / (ORB + DRBopp)]*100, DR% – efficiency percentage of defensive rebounds [DRB / (ORBopp + DRB)]*100, AS% – percentage of assist efficiency (AS/FGM)*100, TO% – turnover percentage of inefficiency [TOV / (FGA + 0.44 * FTA + TOV)]*100, BS% – block percentage of efficiency (BS/FGA)*100, Off_{eff} – offensive efficiency (PTS/Poss)*100, Def_{eff} – defensive efficiency (PTSopp/Poss)*100, Off_{rtg} – offensive rating [(Tmposs + Oppposs) * PST]/100, Def_{rtg} – defensive rating [(Tmposs + Oppposs) * Oppposs]/100, AS_{rtg} – assist ratio A / [(FGA) + (FTA * 0.44) + (AS) + (TO)], AS/TOrtg – AS/TO, FT_{rtg} – free throw rating FT/FGA, PPP – point per possession PTS/Poss, USG% – usage percentage (TGA + TO + 0.44 * FTA) / Poss, and Poss –possession FGA + 0.475(or 0.44) * FTA – ORB + TO.

The winner of the game is the team with the most points scored. The difference in points scored between the winning and losing team is labelled as ΔPTS and is observed as the result of all individual differences of the observed parameters. The formation of the quantitative model for the assessment of the impact of individual observed game parameters on the final score is based on creating a multiple linear regression model where ΔPTS is a subordinate variable, while the differences (Δ) of the other observed game parameters are insubordinate variables. For the purposes of this paper, two regression models were formed, with the same subordinate variable, ΔPTS. The first model was designed to represent a set of insubordinate variables comprising the differences of all relative percentage parameters of the standardly observed game parameters:

$$\Delta PTS = f\begin{pmatrix} \Delta 2\%, \Delta 3\%, \Delta FG\%, \Delta eFG, \Delta FT\%, \Delta OR\%, \\ \Delta DR\%, \Delta AS\%, \Delta TO\%, \Delta BS\%, \Delta TS\% \end{pmatrix}$$

$$\gamma_i = \beta_0 + \sum_{j=1}^{11} \beta_j x_{ji} + \varepsilon_i$$

where the variable labels are: $x_{1i} = \Delta 2\%$, $x_{2i} = \Delta 3\%$, $x_{3i} = \Delta FG\%$, $x_{4i} = \Delta eFG\%$, $x_{5i} = \Delta FT\%$, $x_{6i} = \Delta OR\%$, $x_{7i} = \Delta DR\%$, $x_{8i} = \Delta AS\%$, $x_{9i} = \Delta TO\%$, $x_{10i} = \Delta BS\%$, and x_{11i} = ΔTS%.
The second model was designed to include all insubordinate variables of the relative rating parameters of the game:

$$\Delta PTS = f\begin{pmatrix} \Delta OFF_{eff}, \Delta DEF_{eff}, \Delta OFF_{rtg}, \Delta DEF_{rtg}, \Delta AS_{rtg}, \\ \Delta AS/TO_{rtg}, \Delta FT_{rtg}, \Delta PPP, \Delta USG\% \end{pmatrix}$$

$$\gamma_i = \beta_0 + \sum_{j=1}^{8} \beta_j x_{ji} + \varepsilon_i$$

where the variable labels are: $x_{1i} = \Delta OFF_{eff}$, $x_{2i} = \Delta DEF_{eff}$, $x_{3i} = \Delta OFF_{rtg}$, $x_{4i} = \Delta DEF_{rtg}$, $x_{5i} = \Delta AS_{rtg}$, $x_{6i} = \Delta AS/TO_{rtg}$, $x_{7i} = \Delta FT_{rtg}$, $x_{8i} = \Delta PPP, and\ x_{9i} = \Delta USG\%$.

Mutual relations among the established variables were studied by means of regression and correlation analysis of the designed regression models using gradual regression (stepwise), which defined the conditions for gradual regression for inclusion and exclusion of variables in the model – in particular, criterion F for the inclusion of variables into the equation is of .05 significance, and .10 for exclusion (standard values). Standardization at this level ensured consistency and comparability of results at different levels and in different time periods. Also, the determined variables and their parameters were examined in terms of the level of significance they exhibited (t-test and F test), all with an aim to obtain well-defined models providing ground for valid extrapolation.

RESULTS

Table 1 shows the results of the regression and correlation analysis of the first model and the second model for the standardly observed parameters of the game of basketball.

Table 1. Regression and correlation analysis of the first model and second model at the FIBA EuroBasket Women 2019.

	1st MODEL				2nd MODEL		
	SE	*t*	*p*		*SE*	*t*	*p*
Constant	0.420	0.255	.801	Constant	0.203	0.837	.408
ΔTS%	0.042	28.560	.000	ΔOFF_{eff}	0.029	13.133	.000
ΔTO%	0.047	-22.451	.000	ΔDRF_{eff}	0.027	-13.100	.000
ΔDR%	0.024	12.156	.000				

From the obtained regression models and based on the partial correlation coefficient, it can be concluded that the final score of games at the FIBA EuroBasket Women 2019, in the first model, was influenced the most by variables ΔTS% – true shooting percentage (β = .824, *p* < .000) with partial correlation r_p = .980, ΔTO% – turnover percentage of inefficiency (β = -.644, p < .000) with partial correlation r_p = -.968, and ΔDR% – efficiency percentage of defensive rebounds (β = .346, p < .000) with partial correlation r_p = .902.

Variables with the greatest impact on the final score in the second model were: ΔOFF_{eff} – offensive efficiency (β = .507, p < .000) with partial correlation r_p = .912, and ΔDEF_{eff} – defensive efficiency (β = -.506, p < .000) with partial correlation r_p = -.911.

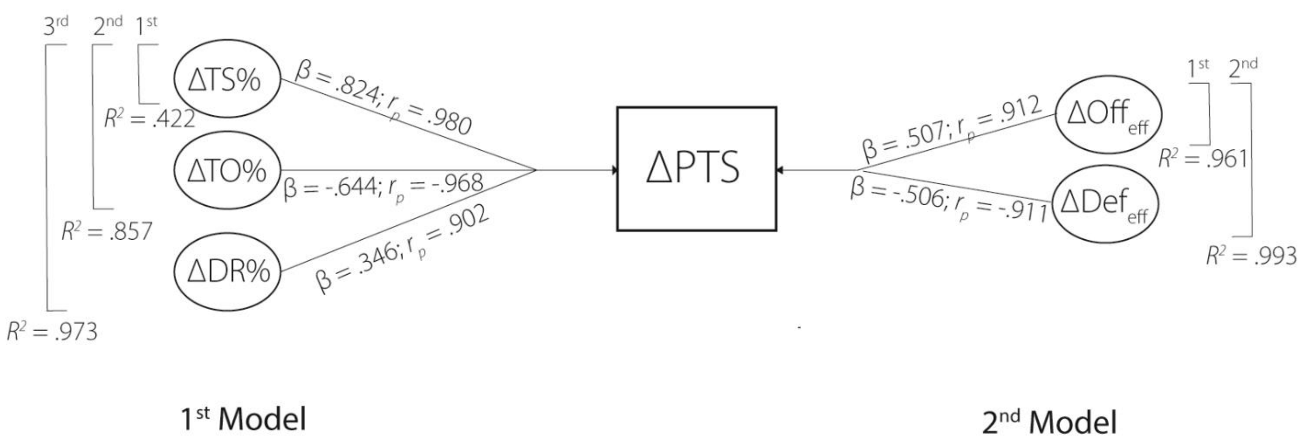
Partial correlation values (r_p) are particularly noteworthy, as they express the significance of the influence that certain selected variables have on the final score of the game. At the same time, the influence of the other variables is deemed to be unaffected. As we can see, for the variables obtained in this paper the influence is deemed to be very high.

Based on the obtained results, which are shown in Table 2, it can be concluded that regression models are statistically significant in relation to the included variables. Both models show significant correlation between subordinate variable (ΔPTS) and the set of insubordinate variables included in the model.

Table 2. ANOVA of the first and second model at the FIBA EuroBasket Women 2019.

	1st MODEL					2nd MODEL				
	Total	*df*	*s*	*F*	*p*	*Total*	*df*	*s*	*F*	*p*
Regression	2687.033	3	895.678	411.855	.000	2742.738	2	1371.369	2632.104	.000
Residual	73.941	34	2.175			18.236	35	0.521		
Total	2760.974	37				2760.974	37			

All of the above leads to the conclusion that in all models, according to the Chaddock scale, there is a firm correlation between the subordinate variable PTS, i.e., ΔPTS, and the relevant sets of insubordinate variables.



Key: ΔPTS – difference in points scored; ΔTS% – difference in true shooting percentage; ΔTO% – difference in turnover percentage of inefficiency; ΔDR% – difference in efficiency percentage of defensive rebounds; ΔOFF_{eff} – difference in offensive efficiency; ΔDEF_{eff} – difference in defensive efficiency; R^2 - adjusted R square stepwise regression; β - standardized coefficient beta; r_p – partial correlation coefficient.

Figure 1. Variables included in the models at the FIBA EuroBasket Women 2019.

Figure 1 gives a graphic representation of the variables included in the first model of the individual iteration, i.e., values of adjusted *R* square in each iteration. The values of adjusted *R* square up to the final iteration step are: (1st) R^2 = .422, $F(1, 36)$ = 26.265, p < .000; (2nd) R^2 = .857, $F(2, 35)$ = 104.729, p < .000; and (3rd) R^2 = .973, $F(3, 34)$ = 411.855, p < .000. When it comes to variables included in the second model, the iterations are: (1st) R^2 = .961, $F(1, 36)$ = 887.350, p < .000, and (2nd) R^2 = .993, $F(2, 35)$ = 2632.104, p < .000.

DISCUSSION

It is possible to form numerous regression models. The basic question is why a model was not formed based on absolute variables, which was used in previous studies using this method (Simović and Komić, 2008; Simović et al., 2012; Simović et al., 2018; Simović et al., 2019)? Statistical analysis of the model with absolute variables isolated two variables with a significant impact on the outcome of a game (ΔPTS). They are ΔMFG and ΔMFT, which explain for 89.1% of the phenomenon (R^2 = .891, $F(2, 35)$ = 142.698, p < .000) with very high ΔMFG (r_p = .942) and medium high partial correlation ΔMFT (r_p = .791). The ΔMFG variable, isolated in the first iteration, explains 70.0% of the phenomenon (R^2 = .700, $F(1, 36)$ = 87.166, p < .000). Analysis of the FIBA EuroBasket Women 2017 yielded identical results [24], where the same variables were isolated (ΔMFG and ΔMFT) in matches of the final two rounds of the competition. For the entire championship, aside from these two variables, ΔM2 emerges as significant as well. For this reason, we felt that it was not necessary to show the data in the results, but rather that it would be sufficient to comment on them in the discussion.

In any case, the impact of field goals on the final score of basketball games is undeniable. Field goals are the most studied basketball performance parameter which contributes to victory and is directly related to success (Hofler and Payne, 1997). It is clear that the team with the higher field goal percentage (FG%) has a greater chance to win the match, and if you have the same or even lower FG% than the opponent, you can only win the match if you have more field goals attempted (FGA) or if you have more free throws attempted (FTA) or a better free throw percentage (FT%). To secure a victory, you need to be better in three out of these four items. Although the other basketball skills that we call fundamental (passing, dribbling, defence and rebounding) may provide a high shot percentage for a player, he or she still has to be able to score. On that note, Dean Oliver identified four key factors required to win a match, two of which are related to field goals: shot efficiency and number of free throws, the other two being offensive rebounds and turnovers (Oliver, 2004). Studies conducted so far for top-tier women's basketball confirmed the significance of field goals, especially short-range and mid-range shot efficiency, which make up the majority of shots (Kreivytė and Čižauskas, 2007, 2010), although the frequency of these shots is decreasing (albeit without a change in shot efficiency), with rising numbers of long-range shots (Kreivyte et al., 2011). This indicates that coaches are more than aware of the significance of shooting skills and that there is significant room for their improvement through training. A study by Daniele Conte and Inga Lukonaitiene, conducted at the FIBA EuroBasket Women 2017, showed that winning teams, compared to losing teams in a game, score more points in the paint, points from turnovers and second chance points after a successful offensive rebound (2018). This further corroborates the age-old observation that the main difference between men's and women's teams is that female players prefer shooting from good positions inside the paint instead of near the 3-point line as occurs in men's games (Mavridis et al., 2003).

Basketball experts have long noticed that the sheer sum of gathered indicators is not in itself sufficient for a detailed analysis of all events taking place during a game (Simović et al., 2012). One of the first to deal with this issue was Dean Smith, who noted that the number of rebounds itself is not a reliable indicator, but instead that it is the efficiency of such rebounding (1999). All of this lead to the practice of not using relative statistical indicators as is, but trying to mathematically model different formulas which should aid in making conclusions on game performance (Aizemberg et al., 2014; Csataljay et al., 2012; Kubatko et al., 2007; Mikołajec et al., 2013). Jose Martinez may have best described the current situation in the field when he said that "*To find best measure to valuate a basketball player is becoming like the search of the 'Holy Grail'*" (2012, p. 21). The problem researchers are facing, and which was pointed out as early as 1995 by Jean-Francis Gréhaigne and Paul Godbout, is in the non-linearity of relations between efficiency and multidimensionality and unpredictability of player behaviour in specific, ever-changing game conditions. This is why some authors point out that it is no wonder that there are constant efforts to come up with new criteria systems (Trninić et al., 2000). This problem was perhaps best described by the great coach Pat Riley, who said he was certain not all skills can be measured mechanically, but it is certain that they were all measurable in one way or another and that the events observed and noted during matches can be expressed in numbers (1993).

This is why two models were offered in this study. The first is based on percentages of the standardly observed game parameters, and the second on their relative rating. This is our first study in which we came to these variables-based experiences and research done in the NBA league.

An analysis of the first model shows that the first iteration again yielded a field goal variable - true shooting percentage (ΔTS%) which explains 42.2% of the observed phenomenon. This supports the results obtained through analysis of relative indicators mentioned at the beginning of the discussion, and also a fact pointed out by Rasa Kreivyte et al., that: "*The team game and its changes can be evaluated by analysing quantitative (shooting from different distances, free throws, rebounds, etc.) and qualitative (shooting efficiency, diversity, etc.) indicators*" (2013, p. 47). True shooting percentage is an APBRmetrics statistic (Association for Professional Basketball Research Metrics), the purpose of which is to give a more precise calculation of shot efficiency for both the individual players and the team. If we analyse the formula, we can see that it takes two variables which are recorded during matches: field goals attempted (AFG) and free throws attempted (AFT). Analysis of the relative model for the previous FIBA EuroBasket Women 2017 determined that it was ΔMFG and ΔMFT that had an influence on ΔPTS (Simović et al., 2017), which indicates that we now merely have a more precise estimate of efficiency, and that variables with an influence on the final score have remained the same, even though they are the number of shots attempted and shots made. This study has previously explained how these parameters can bring a victory. In any case, other researchers have also reached conclusions on the impact of field goal efficiency on the final score in women's basketball (Gómez et al., 2006; Kreivytė and Čižauskas, 2007, 2010; Leicht et al., 2017), as well as the efficiency of free throws (Gómez et al., 2006; Milanović et al., 2016; Nakić, 2004). At the same time, FG% or its variants are one of the most commonly used measurements in basketball when assessing offensive capability (Hickson and Waller, 2003; Piette et al., 2010), and, in all collective sports, shot precision is an indicator of the highest level of competence and a guarantee for achieving great results in sports (Milanović et al., 2016). Studies have shown that FG% is a key factor of team success for young female basketball players as well (Koh et al., 2012).

In addition to ΔTS%, in the first model, two more variables presented as significant for the final score at the most recent European Championship. They are turnover percentage of inefficiency (ΔTO%) and efficiency percentage of defensive rebounds (ΔDR%). ΔTS% and ΔTO% explain 85.7% of the observed phenomenon, and after ΔDR% joins them in the third iteration, they explain 97.3% of the phenomenon. Slavko Trninić pointed out that turnovers reduce the shot percentage of the team, and increase that of the opponent, resulting in dual failure (2006). In the analysis, loss of ball in possession, which provides opportunities for the opponent executing an offence (bad pass, bad catch, bad dribbling), should be separated from game rule violations (which result in turnovers). The former is essentially the result of quality aggressive defence and open the door to transitional offences, which have a high percentage of short-range shots. A study by Anastasia Fylaktakidou, Evangelos Tsamourtzis, and Georgios Zaggelidis showed that the frequency of TOs in women's basketball is higher than mention in literature and for men's teams (2011). The study further notes that passing is the most common cause of TO (40.2%). This was interpreted in two ways. Firstly, through the offence control tactics which result in more passes, for which a long time ago Jay Mikes explained that with more passing before executing a shot, there is a higher risk of a TO (1980). Secondly, passing is the easiest way to get the ball across the court. At the same time, trying to increase passing precision increases the possibility of a TO. Hence, perfecting passing techniques reduces the number of TOs and increases offensive efficiency (Theocharopoulos et al., 2002), because a team that is capable of controlling the rhythm of the offence using efficient passes has a higher chance of getting into a shot position (Stavropoulos et al., 2001). Also, studies have shown that TOs are important because they bring more possessions to the team (Gómez et al., 2013; Șentuna et al., 2018). In short, it can be concluded that passing and receiving the ball are the basis of the collective dynamic of basketball and that passing is the second most important technical element in basketball, after shooting (Nunes et al., 2016; Oliver, 2004). Next after TOs due to mistakes in passing are ballhandling (23.9%) and travelling (23.6%) (Fylaktakidou et al., 2011). These variables (ΔTO%) had a significant impact on scores in basketball in the previous Women's European Championship (Simović et al., 2018) which, aside from the impact of this variable on the final score, points to its consistency. In addition, it points to an evolution of play in women's basketball, because previous studies showed that TO did not make a difference between winning and losing teams (Fylaktakidou et al., 2011).

The third variable that made a difference between winning and losing teams at this European Championship is ΔDR%. The importance of defensive rebounds in women's basketball and its relation to winning teams was established in late last century (Graber, 1998; Sampio, 1998). Later, the relation was identified in other studies on women's basketball (Gómez et al., 2006; Leicht et al., 2017; Milanović et al., 2016; Nakić, 2004). Higher numbers of defensive rebounds indicate overall defensive and rebounding efficiency (Trninić, 1996), while having in mind that studies by Gabor Csataljay et al. confirmed that: "*consequences rebounding percentages should be used both in offence and in defence instead of the number of rebounds*" (Csataljay et al., 2012, p. 363). Good defensive rebounding allows for faster transformation from defence into offence and for opening up a counterattack or semi-counterattack, resulting in scoring easy points (Sampaio and Janeira, 2003), but also in further acceleration of the pace of the game. It should be noted that some researchers determined that women's teams that are dominant in rebounding and have won games have had taller players, especially in shooting guard and forward positions (Carter et al., 2005). The impact of DR on the final score was determined for U18 women's teams at continental championships (Madarame, 2018c).

A study by Anthony Leicht et al. on Olympic women's tournaments from 2004 to 2016 yielded results similar to that of this study, i.e., that the final score in games was affected by FGM, TO and DR (Leicht et al., 2017).

When it comes to the second mode, formed based on relative rating parameters, the second iteration isolated two variables pertaining to offensive and defensive efficiency. It can be noticed that the variable Off_{eff}, isolated in the first iteration, explains 91.2% of the observed phenomenon (R^2 = .912, F(1, 36) = 887.350, p < .000), indicating a high statistical significance of offensive efficiency in this competition. This confirms the age-old observation by numerous basketball experts and theoreticians across the world that, although the game of basketball has two stages (offence and defence), the sum total of all offences with varying lengths, their characters and offensive efficiency prove to be key to the assess of content, markings and final score. Boris Bazanov and Indrej Rannama point out that: "*The offense efficiency coefficient is considered to be one of the main indicators in basketball*" (Bazanov and Rannama, 2015, p. 50), and Dean Oliver found that this is particularly pronounced in lower-tier competitions and junior competitions (2004). The evolution of the offence in basketball displays increasing dynamics (Bazanov, 2007; Zhang et al., 2010), which is a trend for women's basketball as well (Bazanov and Rannama; 2015). An additional challenge rises here for coaches, to understand the causes of these quantified results based on this index (Correiaet al., 2013; Page et al., 2014), including the fact that "*the preparations for a team to be successful in basketball court involve the use of very complex strategies*" (Șentuna et al., 2018, p. 146). On the other hand, studies have shown that in modern basketball offensive efficiency depends primarily on the balance between outside games and post games (Courel-Ibáñez et al., 2017; Gomez et al., 2016; Mavridis et al., 2004), which is vital to the improvement of performance, training process planning and preparation for a match or competition (Lemmink and Frencken, 2013). In any case, the results of this study indicate that outside and post play are balancing out in European women's basketball, because unlike the analysis of the previous continental championships in 2017, when M2 was isolated as a variable significant for victory in basketball, this time it was only the variable MFG, which includes both outside (M3) and post play (M2). Further, it can be seen that with the increase in game dynamics there is a decrease of dribblings, and passing as well, with an increased risk for passing, which may explain the emergence of ΔTO, which is in contradiction to the results of previous studies (Fylaktakidou et al., 2011; Mikes, 1987).

Regardless of its limitations, which primarily have to do with the fact that the data was gathered by someone else (Škegro, 2013) and that authors often do not carry out any analysis of variable reliability (Hughes et al., 2002), notational analysis is still a vital tool for coaches in collective sports, basketball in particular, to have valid and reliable data on their teams and opponents (Sampaio et al., 2010). The results of notational analysis, which define player and team performance using statistics, facilitate decision-making, primarily for the coach, as Kun-Tzu Yu, Zhong-Xin Su, and Rui-Chen Zhuang pointed out that the players' technical and tactical skills require continuous and systematic logging and analysis, in order to monitor their evaluation with the aim to improve both individual and team training sessions (2008). When it comes to women's basketball, then it may be most fitting to quote Miguel Gómez at al., who say that: *"... women's basketball analysis through game-related statistics would seem to be an important area of research, because the teams' and players' performance differ as a function of the gender"* (2009, p. 278).

CONCLUSION

The results of this study show that in the women's EuroBasket 2019, the TS% variable, which comprises FGM and FTM, but also TO, DR and Off_{eff} made the difference between winning and losing teams in matches at the FIBA EuroBasket Women 2019. Identical results, excluding the variable Off_{eff}, which had not been researched up to that point, was isolated in the previous championship, in 2017, but also in studies on Olympic women's tournament, which indicates continuous influence of these variables. Among the isolated variables, the dominant ones are field goals, but no longer is women's basketball play dominated by post play, as was the case in the previous championship, but now there is a balance between outside and post play. This is not much of a surprise since in all collective sports shot efficiency indicates high levels of a team's preparedness and willingness to achieve good sport results. Aside from field goals, coaches of women's teams should pay attention to passing technique, which is the main cause of turnovers. The increased offensive dynamics and comparable quality of teams in top-tier competitions have decreased dribbling, and also passing is reduced, but with an increased risk, which leads to more turnovers. In women's basketball there is significant room for improvement of passing since TO is one of the variables that distinguish men's from women's teams the most. In addition, winning teams have a higher DR percentage compared to the number of shot opportunities, which primarily takes away the opponents' ability to make more than one shot per possession, thus reducing their shot percentage. Technique and individual and group rebounding tactics in defence is prominent in women's basketball if the team is inferior in height than the opponents. The variable of offensive efficiency indicates the importance of technical and tactical qualities of female players and their integration into the group and collective tactics and team concept. Studies have shown that this index is especially prominent at lower-tier competitions and competition of junior teams, but now in women's basketball as well. How to interpret this index is still a challenge for coaches and researchers because of the multicomplexity that occurs in the offense in basketball.

AUTHOR CONTRIBUTIONS

Conceptualization: Slobod Simović and Jasmin Komić. Methodology: Jasmin Komić. Validation: Slobodan Simović and Jasmin Komić. Formal Analysis: Bojan Guzina and Goran Pašić. Investigation: Slobodan Simović and Jasmin Komić. Resources: Tamara Karalić and Goran Pašić. Data Curation: Goran Pašić. Writing – Original Draft Preparation: Slobodan Simović. Writing – Review & Editing: Zoran Pajić. Supervision: Jasmin Komić and Zoran Pajić. Project Administration: Bojan Guzina. Funding Acquisition: Goran Pašić.

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No potential conflict of interest was reported by the authors.

REFERENCES

Aizemberg, L., Roboredo, M.C., Ramos, T.G., Soares de Mello, J.C., Meza, L.A., & Alves, A.M. (2014). Measuring the NBA teams' cross-efficiency by DEA game. American Journal of Operations Research, 4, 101–112. https://doi.org/10.4236/ajor.2014.43010

Barris, S., & Button, C. (2008). A review of vision-based motion analysis in sport. Sports Medicine, 38(12), 1025-1043. https://doi.org/10.2165/00007256-200838120-00006

Bazanov, B. (2007). Integrative approach of the technical and tactical aspects in basketball.coaching. Unpublished Doctoral dissertations on social sciences, Tallinn University, Estonian.

Bazanov, B., & Rannama, I. (2015). Analysis of the offensive teamwork intensity in elite female basketball. Journal of Human Sport and Exercises, 10(1), 47–51. https://doi.org/10.14198/jhse.2015.101.05

Blanco, V., Salmerón, R., & Gómez-Haro, S. (2018). A multiplication selection system based on player performance: Case study – The Spanish ACB Basketball League. arXiv:1802.07039 [math.OC], 27, 1029–1046. https://doi.org/10.1007/s10726-018-9583-9

Carter, J. E. L., Ackland, T. R., Kerr, D. A., & Stapff, A. B. (2005). Somatotype and size of elite female basketball players. Journal of Sports Sciences, 23(10), 1057−1063. https://doi.org/10.1080/02640410400023233

Celeux, G., & Robert, V. (2015). Towards an objective team efficiency rate in basketball, Journal de la Société Française de Statistique, 156(2), 51–68.

Conte, D., Favero, T. G., Lupo, C., Francioni, F. M., Capranica, L., & Tessitore, A. (2015). Time-motion analysis of Italian elite women's basketball games: Individual and team analyses. Journal of Strength and Conditioning Research, 29(1), 144−150. https://doi.org/10.1519/jsc.0000000000000633

Conte, D., & Lukonaitiene, I. (2018). Scoring strategies differentiating between winning and losing teams during FIBA EuroBasket Women 2017. Sports (Basel), 6(2), e50. https://doi.org/10.3390/sports6020050

Correia, V., Araújo, D., Vilar, L., & Davids, K. (2013). From recording discrete actions to studying continuous goaldirected behaviours in team sports. Journal of Sports Sciences, 1(5), 546–553. https://doi.org/10.1080/02640414.2012.738926

Courel-Ibáñez, J., Suárez-Cadenas, E., & Cárdenas-Vélez, D. (2017). Inside game ball transitions according to players' specific positions in NBA basketball. Cuadernos de Psicologia Del Deporte, 17(3), 239–248.

Csataljay, G., Hughes, M., James N., & Dancs, H. (2012). Pace as an influencing factor in basketball. In Hughes, M., Dancs, H., Nagyváradi, K., Polgár, T., James, N., Sporis, G., Vuckovic, G., & Jovanović, M. (Eds.), Conference Research Methods and Performance Analysis (pp. 178–187). Sopron, Hungary: University of West Hungary.

Dimitros, E., Garopoulou, V., Bakirtzoglou, P, & Maltezos, C. (2013). Differences and discriminant analysis by location in A1 Greek women's basketball league. Sport Science, 6(1), 33–37.

Fylaktakidou, A., Evangelos, T., & Zaggelidis, G. (2011). The turnovers analysis to the Women's National League Basketball Games. Sport Science Review, 20(3-4), 69−83. https://doi.org/10.2478/v10237-011-0055-2

Fylaktakidou, A., Evangelos, T., & Zaggelidis, G. (2011). The effecticeness of types of shots in relation to position of execution of shots in women's basketball. Sudia UBB Educatio Aatis Gymn., 62(2), 39−51.

Gomez, M.Á., Gasperi, L., & Lupo, C. (2016). Performance analysis of game dynamics during the 4th game quarter of NBA close games. International Journal of Performance Analysis in Sport, 16(1), 249–263. https://doi.org/10.1080/24748668.2016.11868884

Gómez, M.A., Lago-Peñas, C., & Pollard, R. (2013). Situational variables. In McGarry, T., O'Donoghue, P., and Sampaio, J. (Eds). Routledge handbook of sport performance analysis (pp. 259–269). London, UK: Routledge. https://doi.org/10.4324/9780203806913.ch21

Gómez, M.A., Lorenzo, A., Ibáñez, S. J., & Sampaio, J. (2013). Ball possessions effectiveness in men´s and women's elite basketball according to situational variables in different game periods. Journal of Sports Sciences, 31(14), 1578-1587. https://doi.org/10.1080/02640414.2013.792942

Gómez, M.A., Lorenzo, A., Ortega, E., Sampaio, J.; & Ibáñez, S.J. (2009). Game related statistics discriminating between starters and nonstarters players in Women's National Basketball Association League (WNBA). J. Sports Sci. Med., 8, 278–283.

Gómez, M. Á., Lorenzo A., Sampaio, J., & Ibáñez, S. J. (2006). Differences in game-related statistics between winning and losing teams in women's basketball. Journal of Human Movement Studies, 51(5), 357–369.

Graber, L.M. (1998). The relationship between rebounding and winning percentage N.C.A.A. Division I Big Sky Conference women´s basketball. Exercise and Sport Sciences, 12(1), 2.

Gréhaigne, J. F., & Godbout, P. (1995). Tactical knowledge in team sports-from a constructivist and cognitivist perspective. Quest, 47(4), 490-550. https://doi.org/10.1080/00336297.1995.10484171

Gréhaigne, J. F., Godbout, P., & Bouthier, D. (1997). Performance Assessment in Team Sports. Journal of Teaching in Physical Education, 16(4), 500–516.https://doi.org/10.1123/jtpe.16.4.500

Hickson, D. A., & Waller, L. A. (2003). Spatial analyses of basketball shot charts: An application to Michael Jordans 2001 - 2002 NBA season. Technical Report. Atlanta, GA: Department of Biostatistics, Emory University.

Hofler, R.A., & Payne, J.E. (1997). Measuring efficiency in the National Basketball Association. Economics letters, 55(2), 293–299. https://doi.org/10.1016/s0165-1765(97)00083-9

Hughes, M.D., Cooper, S-M., & Nevill, A. (2002). Analysis procedures for non-parametric data from performance analysis. International Journal of Performance Analysis in Sport, 2(1), 6–20. https://doi.org/10.1080/24748668.2002.11868257

Hughes, M.D., & Bartlett, R.M. (2002). The use of performance indicators in performance analysis. J Sports Sci, 20(10), 739-754. https://doi.org/10.1080/026404102320675602

Huges, M.D., & Franks, I.M. (2004). Notational analysis of sport: better systems for improving coaching and performance. 2nd ed. London, UK: E. & F.N. Spon. https://doi.org/10.4324/9780203641958

Kioumourtzoglou, E., Derri, V., Tzetzis, G., & Theodorakis, Y. (1998). Cognitive, perceptual, and motor abilities in skilled basketball performance. Percept Mot Skills, 86(3), 771–786. https://doi.org/10.2466/pms.1998.86.3.771

Koh, K.T., Wang, C.K.J, & Mallett, C.J. (2012). Discriminating factors between successful and unsuccessful elite youth Olympic female basketball teams. International Journal of Performance Analysis in Sport, 12(1), 119–131. https://doi.org/10.1080/24748668.2012.11868588

Koh, K., John, W., & Mallett, C. (2011). Discriminating Factors between Successful and Unsuccessful Teams: A Case Study in Elite Youth Olympic Basketball Games, Journal of Quantitative Analysis in Sports, 7(3). https://doi.org/10.2202/1559-0410.1346

Kreivyte, R., Emljanovas, A., Sporiš, G., Knjaz, D., Vučković, G, & Milanović, Z. (2013). Shooting performance did not change in elite women's national basketball teams from 1995 to 2011. Annales Kinesiologia, 4(1), 45–56.

Kreivytė, R., & Čižauskas, A. (2007). Alternation of indices of shots made by the best world women's basketball teams. Ugdymas Kūnokultūra Sportas, 2(65), 30–36.

Kreivytė, R., & Čižauskas, A. (2010). Differences of indicators in competitive performance between winning and losing teams in basketball. Ugdymas Kūnokultūra Sportas, 2(77), 41–48.

Kubatko, J., Oliver, D., Pelton, K., & Rosenbaum, D.T. (2007). A starting point for analyzing Basketball statistics. Journal of Quantitative Analysis in Sports, 3(3), 1–22. https://doi.org/10.2202/1559-0410.1070

Leicht, A., Gomez, M., & Woods, C. (2017). Team performance indicators explain outcome during women's basketball matches at the Olympic Games. Sports (Basel), 5(4), e96. https://doi.org/10.3390/sports5040096

Lemmink, K., & Frencken, W. (2013). Tactical performance analysis in invasion games: Perspectives from a dynamic system approach with examples from soccer. In McGarry, T., O'Donoghue, P., & Sampaio, J. (Eds.), Routledge handbook of sports performance analysis (pp. 89-100). Oxfordshire and New York, UK and USA: Routledge. https://doi.org/10.4324/9780203806913.ch8

Madarame, H. (2018a). Defensive rebounds discriminate winners from losers in European but not in Asian women's basketball championships. Asian J. Sports Med., 9, e67428. DOI: 10.5812/asjsm.67428. https://doi.org/10.5812/asjsm.67428

Madarame, H. (2018b). Regional differences in women's basketball: A comparison among continental championships. Sports (Basel), 6(3), e65. https://doi.org/10.3390/sports6030065

Madarame, H. (2018c). Basketball Game-Related Statistics that Discriminate among Continental Championships for Under-18 Women. Sports (Basel), 6(4), e114. https://doi.org/10.3390/sports6040114

Madarame, H. (2018d). Age and sex differences in game-related statistics which discriminate winners from losers in elite basketball games. Motriz: rev. educ. fis., 24(1), e1018153. https://doi.org/10.1590/s1980-6574201800010001

Martinez, J.A. (2012). Factors determining production (FDP) in basketball. Economics and Business Letters, 1(1), 21-29. https://doi.org/10.17811/ebl.1.1.2012.21-29

Mavridis, G., Laios, A., Taxildaris, K., & Tsiskaris, G. (2004). Developing offense in basketball after a return pass outside as crucial factor of winning. Inquiries in Sport and Physical Education, 2(1), 81–86.

Messersmith, L.L., Laurence, J., & Randels, K. (1940). A study of distances traversed by college men and women in playing the game of basketball. Research Quarterly, 9(3), 30–31. https://doi.org/10.1080/10671188.1940.10627262

Mikes, J. (1987). Computer breakdown of percentage basketball. Scholastic Coach, 57(4), 52–54.

Mikołajec, K., Maszczyk, A., & Zając, T. (2013). Game Indicators Determining Sports Performance in the NBA. Journal of Human Kinetics, 37(1), 145–151. https://doi.org/10.2478/hukin-2013-0035

Milanović, D., Štefan, L., Sporiš, G., & Vuleta, D. (2016). Effects of game-related statistics parameters on final outcome in female basketball teams on Olympic Games in London 2012. International Journal of Current Advanced Research, 5(8), 1186–1189.

Miner, N., Hodgson, P.A, & Espenshade, A. (1940). Study of distance traversed and time spent in active play in women's basketball, Research Quarterly, 9, 95–101.

Moreno, E., Gómez, M.A., Lago, C., & Sampaio, J. (2013). Effects of starting quarter score, game location, and quality of opposition in quarter score in elite women's basketball. Kinesiology, 45(1), 48–54. https://doi.org/10.1080/17461391003699104

Nakić, J. (2004). Differences in standard and derived situation efficacy parameters between men's and women's basketball teams in senior European basketball championships in 2003. Unpublished master thesis, University of Zagreb, Croatia.

Nevill, A., Atkinson, G., & Hughes, M. (2008). Twenty-five years of sport performance research in the Journal of Sports Sciences. Journal of Sports Sciences, 26(4), 413–426. https://doi.org/10.1080/02640410701714589

Nunes, H., Iglesias, X., Daza, G., Irurtia, A., Caparrós, T., & Anguera, M. T. (2016). The influence of pick and roll in attacking play in top-level basketball. Cuadernos de Psicologia Del Deporte, 16(1), 129–142.

Oliver, D. (2004). Basketball on paper: Rules and tools for performance analysis. Washington, DC, USA: Brassey´s, Inc.

Page, G.L., Fellingham, G.W., & Reese, C.S. (2014). Using box-scores to determine a position's contribution to winning basketball games. Journal of Quantitative Analysis in Sports, 4(3), 1–18. https://doi.org/10.2202/1559-0410.1033

Piette, J., Anand, S., & Zhang. K. (2010). Scoring and shooting abilities of NBA players. Journal of Quantitative Analysis in Sports, 6(1), 1–25. https://doi.org/10.2202/1559-0410.1194

Ribas, R.L., Navarro, R., Tavares, F., & Gómez, M.A. (2011). Analysis of number of players involved in rebound situations in Euroleague basketball games. Open Sports Sciences Journal, 4, 10-13. https://doi.org/10.2174/1875399x01104010010

Riley, P. (1993). The winner within: A life plan for team players. New York, NY: Putnam's.

Sampio, J., Cachulio, C., & Janeira, M. (1998). Quantitative analysis in Women's Basketball: identifying variables and game periods related to final outcome. In Hughes, M., & Tavares, F. (Eds.), Proceedings of the 4th World Congress of Notational Analysis of Sport. Porto, Portugal: Centre for Team Sports Studies, Faculty of Sport Sciences and Physical Education, University of Porto.

Sampaio, J., Drinkwater, E.J., & Leite, N. (2010). Effects of Season Period, Team Quality, and Playing Time on Basketball Players' Game-Related Statistics. European Journal of Sport Sciences, 10(2), 141–149. https://doi.org/10.1080/17461390903311935

Sampaio, J., Ibáñez, S.J., & Lorenzo, A. (2013). Basketball. In McGarry, T., O'Donoghue, P., & Sampaio, J. (Eds.), Routledge Handbook of Sports Performance Analysis (pp. 357–366). Oxfordshire and New York, UK and USA: Routledge. https://doi.org/10.4324/9780203806913.ch28

Sampaio, J., & Janeira, M. (2003). Statistical analysis of basketball team performance: understaanding team´s wins and losses according to a different index of ball possesions. International Journal of Performance Analysis in Sport, 3(1): 40–49. https://doi.org/10.1080/24748668.2003.11868273

Șentuna, M., Șentuna, N., Özdemir, N., Serter, K., & Özen, G. The investigation of the effects of some variables in the playoff games played in Turkey Women's Basketball Super League between 2013–2017 on winning and losing. Phys. Educ. Stud., 22(3), 146–150. https://doi.org/10.15561/20755279.2018.0306

Simović, S., & Komić, J. (2008). Analysis of influence of certain elements of basketball game on final result based on differentiation at the XIII, XIV and XV World Championship. Acta Kinesiologica, 2(2), 57–65.

Simović, S., Komić, J., Guzina, B., Pajić, Z., & Vojvodić, M. (2017). Influence of game related statstical elements on final results in FIBA Eurobasket Women 2017. Facta Universitatis, 16(4), 709–723. https://doi.org/10.22190/fupes181204063s

Simović, S., Komić, J., Matković, B., & Nićin, Đ. (2012). Analysis of results at Eurobasket 2011 – final results of observed elements of basketball game. In Simović, S. (Ed.), Anthropological aspects of sports, physical education and recreation, 3rd International scientific conference (pp. 19–28). Banja Luka, Bosnia and Herzegovina: Faculty of Physical Education and Sport, University of Banja Luka.

Simović, S., Komić, J., Matković, B., Pajić, Z., & Guzina, B. (2019). Analysis of influence basketball game-related statistics on final result based on differentiate at the 2017 FIBA Asia Cup. Asia Journal of Sport Medicine, e69109. https://doi.org/10.5812/asjsm.69109

Simović, S., Matković, B., Mijanović, M., Kocić, M., & Vojvodić, M. (2012). Structure of efficiency factor at XIII, XIV, XV, and XVI World Championship in basketball. Journal of Human Sport and Exersises, 7(2), 527–543. https://doi.org/10.4100/jhse.2012.72.16

Simović, S., & Pavlović, P. (2013). Basketball on the territory of the former Yugoslavia until May 1945. Banja Luka, Bosnia and Herzegovina: University of Banja Luka, Faculty of Physical Education and sport.

Škegro, D. (2013). Evaluating different types of attack in a basketball game based on their start, outcome, duration and number of additions. Unpublished Doctoral dissertation, University of Zagreb, Faculty of Kinesiology, Croatia.

Smith, D. (1999). Basketball, multiple offense and defense. 4th ed. Boston, MA: Allyn and Bacon.

Stavropoulos, N., Gerodimos, B., Tzouvaris, G., & Kellis S. (2001). Basic passing types in the maximisation of success in the modern Basketball. Athletic Performance and Health, 3(3), 167–173.

Theocharopoulos, A., Tsitskaris, G., & Garefis A. (2012). Types of passing and their effectiveness in female basketball. Woman and Sport, 1(1), 59-68.

Trninić S. (1996). Analysis and learning of basketball game. Pula, Croatia: Vikta.

Trninić, S. (2006). Selection, preparation and leadership of basketball players and teams. Zagreb, Croatia: Vikta- Marko d.o.o.

Trninić, S., Dizdar, D., & Dežman, B. (2000). Empirical verification of the weighted system of criteria for the elite basketball players quality evaluation. Collegium Anthropologicum, 24(2), 431–442.

Veleirinho, A., & Tavares, F. (2013). Did the three point line change influence the female youth basketball? Analysis of the predictive factors from winning teams (U-16 and U-20). Revista de Psicología del Deporte, 22(1), 283–287.

Volossovitch, A. (2017). Research topics in basketball. In Passos, P., Araújo, D., & Volossovitch, A., (Eds), Performance Analysis in Team Sports (pp. 173–199). Oxfordshire and New York, UK and USA: Routledge.

Yu, K-T, Su Z-S, & Zhuang, R-C. (2008). An exploratory study of long-term performance evaluation for elite basketball players. International Journal of Sports Science and Engineering, 2(4), 195–203.

Zhang, T., Hu, G., & Liao, Q. (2010). Analysis of offense tactics of basketball games using link prediction. In Matsuo, T., Ishii, N., & Lee, R. (Eds), 12th IEEE/ACIS International Conference on Computer and Information Science – Proceedings (pp. 207–212). Niigata, Japan: ACIS International. https://doi.org/10.1109/icis.2013.6607842