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Performance Indicators of the Top Basketball Players: Relations with Several Variables

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ABSTRACT

The aim of this study was to determine the differences in performance indicators for top senior male basketball players, with respect to several independent variables: position in the team, total situation-related efficiency, age, playing experience and the time spent on the court within the game and during championship season. The final sample of participants was selected from all teams in A-1 Croatian men's basketball league. Significant differences have been found according to the players': position in the team, total situation-related efficiency, and in interactions of the position in the team / total situation-related efficiency and minutes spent on the court in a game / playing experience. The differences in the situation-related efficiency between players have not been found according to the players' age and the number of games played. Further research can be directed towards deeper analysis of the influence of more complex differentiated variables playing experience and time spent on the court in a game on situation-related efficiency in basketball.

Key words: *difference, MANOVA, performance indicators*

Introduction

The performance indicators are widely studied in the basketball[1,2]. However, the researches of the differences of performance indicators in basketball (in this context, situation-related efficiency) mainly include only one independent variable, such as player's gender, position in team, etc. In this article, a whole set of independent variables is used simultaneously to analyze the differences in two sets of performance indicators, simple (standard) and complex (derived).

For analyzing the performance, the biomechanics and notational approaches are two aspects clearly different that address the scientific knowledge in sports[3,4]. In the notational analysis, the main indicators used are from games (1), tactical (2) and technical (3), providing the information about technical, tactical physiological and psychological demands of basketball[5]. The performance analysis in basketball is focused on the players and the evaluation of the game, attempting to obtain a better insight into the aspects that allow optimization of the resources of players and teams, also to identify the competition demands[6]. This performance analysis has the main purpose of obtaining useful information for adjusting training processes and tasks to the reality of players or teams analyzed[7]. But before collecting any data, it is necessary to carry out the selection of the most important and interesting indicators[4,8]. Basketball is predominantly a strategic team sport in which every player synchronizes his individual technique and tactics with his co-players, through the collective tactics of the team[9,10]. The complexity of basketball prompts researchers to analyze technique, tactics, previous actions, player position, etc.[11,12]. Hence, in basketball especially useful are complex performance indicators, such as: Player Efficiency Rating (PER), a formula developed by Hollinger[13] that determines a per minute rating of the player, while those developed by Richey & Zorn[14] or Morrison & Kalwani[15] show special usefulness in describing the value of the player, in comparison to the others in the league. Additional more complex indices can make player performance prediction based on a statistical timing model, by fitting a player's performance over the time, estimating contract value, and the potential »aging« effects of a certain player[16].

However, in this article, relatively simple performance indicators in basketball (traditional statistics of a game, named situation-related efficiency parameters) are cho-

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sen: points, rebounds, assists, steals, blocks, turnovers and shot attempts. The possibility of analyzing these indicators of situation-related efficiency emerges through adequate conduction of game statistics. Basketball match analysis confirms that performance depends on different determinants, such as: competition level, age and gender[17]. In order for a team to be successful, the team members should recognize their roles and combine them so as to play as a single unit. Basketball players differ according to five position roles (playing positions): point guard, shooting guard, small forward, power forward and centre[18-21]. In terms of the anthropometric characteristics of players who are playing different roles in team, shorter players are usually more successful[22]. Players who are playing different roles in team have also different scores in standard indicators of the playing performance[18,22]. Trninić[18] found significant differences in the results of situation-related efficiency parameters between guards, forwards and centers measured on the final Olympic tournament in Atlanta in 1996. Swalgin[23] showed that four indicators of the playing performance particularly distinguish positions in play: offensive and defensive rebounds, blocked shots, assists and the three-point field goals separately distinguish guards, forwards and centers[24,25]. Career duration can be successfully predicted based on standard situation-related efficiency parameters for basketball players on the positions of guards and shooting guards, but not for those who have played on the center position in the National Basketball Association championship (NBA) was found[26]. In the stages of establishment in a basketball player's life, age is used as a limiting factor in the periods of decision and it is important for defining the formation periods and the time point of the highest sport performance[12]. In national men's basketball teams, the age and positional role differences in fitness performance are found[27]. Except according to the age, playing positions, competition level and gender, the performance analysis in basketball can be useful for providing an insight into some additional (potential) determinants of success, such as the duration of playing in the game and in the whole championship season.

Therefore, the main aim of the study was to determine whether the elite basketball players vary in standard and derived situation-related efficiency parameters in relation to their: playing position in the team (guards versus forwards/centers), total situation-related efficiency (better versus worse), age (younger versus older), basketball experience (more versus less), duration of playing in the game (more or less) and in the whole championship season (more and less). In other words, the objective is focused on analyzing the differences in simple and complex performance indicators in elite male senior basketball players, using few independent variables simultaneously. Namely, the detection of possible differences in the situation-related efficiency in relation to these different factors (and interactions between these factors) can allow coaches to correct undesirable deviations from 'ideal' situation-related efficiency of players who play in certain team positions, experienced players, and/or players with more time spent on the court. However, the insight into these differences can help in: making the profile of a certain team (1); giving a better description of the situation-related efficiency of the players in some championship (2) and describing the characteristics of competition in a specific championship (3). Potential interactions between the chosen independent variables which differentiate situation-related efficiency of the players, can offer the possibility of more sophisticated approach in discussing the problem of the situation-related efficiency in basketball.

Methods

Participants

An intentional sample of participants consisted of top senior Croatian basketball players, playing in nine male senior teams in A-1 Croatian Men's Basketball League in the 2006/2007 championship: »Cedevita«, »Svjetlost«, »Borik«, »Kvarner«, »Dubrava«, »Dubrovnik«, »Alkar«, »Šibenik« and »Osijek«. The age range of participants was large (17-40), with an average age of 23.94±4.89. The final sample of participants (74 basketball players) was selected from the initial sample of 107 participants. In the final sample, basketball players were differentiated according to their position in their team. Conditions for selecting the players in the final sample were the number of minutes in play (minimum ten minutes in play per game), i.e. the number of games played (minimum eight games in which the individual played). Those criteria were derived from the total time in a single game and the total time played in the championship. Each team played 16 games throughout the championship and 8 games (which are half the games played) were chosen to be the lower limit for inclusion of the participants into the sample. On the other hand, the total single game playing time of 40 minutes and one quarter (which is ten minutes) were chosen to be the lower limit for inclusion within the sample. We have estimated that both limits can ensure validity of the results obtained in this study: namely, one quarter of the game is quite a long period that the player is able to play with reliable performance (in other words, the final result of the game is not always known when the player enters the game). Similarly, on the championship level, the position of the team is not certain in most games in which a player is playing. Guards were compared (N_1= 47; point guard and shooting guard) with forwards/centers (N_2= 27; small forward, power forward and centers). All the other categories (dichotomized independent variables) have the same number of participants, split by median (age, basketball experience, minutes playing in the game, games played).

Variables

For assessing the overall quality of basketball players (dependent variables) the partial weighted linear combination method[28-31] was used. There were thirteen standard situation-related efficiency parameters, which include shooting performance successfulness data for one (1FTM), two (1FTG) and three (2FTG) points, offensive (OREB) and defensive (DREB) rebounds, turnovers (TO) and steals (STL), assists (AST), block shots, personal fouls (PF). Based on the above mentioned standard situation-related efficiency parameters, the seven derived coefficients of situation-related efficiency were defined: utilization of two-points shot, utilization of three-point shots, free throw utilization, two-points shot effectiveness, three-point shots effectiveness, free throws effectiveness. Derived situation-related efficiency parameters are: utilization coefficient for two-point shots: 2FGUT = 2FGM / (2FGM + 2FGA); utilization coefficient for three-point shots: 3FGUT = 3FGM / (3FGM + 3FGA); utilization coefficient for free throws: 1FTC = 1FTM / (1FTM + 1FTA); efficiency coefficient for two-point shots: 2FGEC = 2 x 2FGM x 2FGUT; efficiency coefficient for three-point shots: 3FGEC = 3 x 3FGM x 3FGUT; efficiency coefficient for free throws: 1FTEC = 1FTM x 1FTC; total situation-related efficiency: TSE = 1FTM + 2 x 2FGM + 3 x 3FGM + DREB + OREB + AST + STL– 0.5 1FTA – 2FGA – 3FGA – TO – PF. All the situation-related efficiency parameters data were collected from the Croatian Basketball Association official website: URL: http://www.hks-cbf.hr/ (available also on http://kosarka.org). These data correspond with the official logs from the basketball games. In all matches the computed statistics is applied, i.e. Fullcourt program. The data collected using this program can be followed on the official portal of Croatian Basketball Federation (website: www.hks-cbf.com). The statistics is kept by each team separately, while a copy of the computer statistics is provided after the second and fourth quarters, and after every possible game extension. The summary statistics is presented to the assignee matches. The host of the game is required to provide a computer for keeping statistics on the court, as well as Internet access throughout the entire game. Similarly, the host of the game determines statisticians for the game and is responsible for their work. The host is obliged to share statistics with the media after the second and fourth quarters of the game, and after any extensions[32]. In other words, the games were analyzed through systematic observation by three experienced observers trained for this observational analysis. Computed statistics (Fullcourt program) enables the official statisticians to analyze all game situations in detail separately and as a whole, achieving the agreement. This procedure ensures very high level of inter-rater reliability. All official statisticians are experienced observers (licensed in Sport Science and with a minimum of 5 years of experience as basketball coaches). To avoid inconsistencies with the sample, the data about the blocked shots were excluded from the analysis. Therefore, the analysis is based on twelve out of thirteen of these standard situation-related efficiency parameters.

Independent variables in this research were: overall situation-related efficiency, age, basketball experience, minutes playing in game, games played. Total sample of games played (from which the data on the players' and teams' situation-related efficiency were collected) included sixteen matches for each of the nine teams. Therefore, it is a 'runoff' system of competition, in which each team played the other, one home and one away match. This study was conducted with the permission of the Croatian Basketball Association and the clubs, within the period between sixth and eighth round of the A-1 league championship (from the second half of December 2006, until the end of the first half of January 2007).

Statistical analysis

Data analysis was performed using the statistical program SPSS 17.5. Descriptive statistics was calculated for all the experimental data. To estimate the differences between the groups of players in variables of situation-related efficiency, in relation to their positions in the team (guards compared with forwards/centers), total situation-related efficiency (better and worse), age (younger and older), basketball experience (more and less), length of playing in the game (more or less) and in the whole championship season (more and less), multivariate analysis of the variance (MANOVA) was used. Analyses of the relationship between the independent variables directly associated with basketball (games played, minutes spent on the court, total situation-related efficiency, position in the team) and demographic variables (age, basketball experience) with the players' situation-related efficiency parameters were conducted using several separate MANOVAs. To ensure that each sub-sample has more than 30 subjects, as a pre-condition for application of parametrical statistical methods, two variables only were processed at the same time. When significant interactions were found, the file was split by both variables and MANOVAs were conducted with the other variable and only the significant findings were reported. Whenever Levene's test for homogeneity of variance was significant at the $p<.01$ level, nonparametric statistics (Kruskal-Wallis) was used to confirm the effects obtained via the MANOVAs. When significant interactions were found on variables for which Levene's was significant (successful shots for two points, assists, offensive rebounds, turnovers – in basketball variables; unsuccessful shots for two points, successful free throws, unsuccessful free throws, assists, offensive rebounds, turnovers) the file was split by the significant variable and Kruskal-Wallis was used to confirm the effects on the other variable. In all cases, the Kruskal-Wallis tests confirmed the findings of the MANOVAs. In those cases only the results of the MANOVAs were reported. In cases where statistical significance was found in one test but not in the other, they were not reported. Because of the large number of independent and dependent variables, the consequent number of significance tests and the increased possibility of Type I error, only the results significant at the $p<.01$ level were reported.

Results

Significant multivariate effects were found in four tests for the set of standard situation-related parameters and three in the derived situation-related parameters

TABLE 1
MULTIVARIATE EFFECTS FOR STANDARD AND DERIVED SITUATION-RELATED EFFICIENCY PARAMETERS (MANOVA)

Variables	Pillai's Trace	F-test
Standard parameters		
Total situation-related efficiency (df=12; df error=59)	.649	9.086**
Position in team (df=12; df error=59)	.626	8.241**
Total situation-related efficiency * Position in team (df=12; df error=59)	.196	1.201
Age (df=12; df error=49)	.242	1.304
Basketball experience (df=12; df error=49)	.335	2.054*
Minutes playing in game (df=12; df error=49)	.431	3.087**
Games played (df=12; df error=49)	.261	1.442
Age * Basketball experience (df=12; df error=49)	.277	1.561
Age * Minutes playing in game (df=12; df error=49)	.265	1.475
Basketball experience * Minutes playing in game (df=12; df error=49)	.175	.867
Age * Basketball experience * Minutes playing in game (df=12; df error=49)	.189	.951
Age * Games played (df=12; df error=49)	.204	1.046
Basketball experience * Games played (df=12; df error=49)	.148	.710
Age * Basketball experience * Games played (df=12; df error=49)	.155	.749
Minutes playing in game* Games played (df=12; df error=49)	.156	.755
Age * Minutes playing in game* Games played (df=12; df error=49)	.220	1.152
Derived parameters		
Total situation-related efficiency (df=6; df error=65)	.569	14.279**
Position in team (df=6; df error=65)	.356	5.993**
Total situation-related efficiency * Position in team (df=6; df error=65)	.199	2.698*
Age (df=7; df error=54)	.145	1.305
Basketball experience (df=7; df error=54)	.151	1.373
Minutes playing in game (df=7; df error=54)	.196	1.879
Games played (df=7; df error=54)	.108	.935
Age * Basketball experience (df=7; df error=54)	.073	.608
Age * Minutes playing in game (df=7; df error=54)	.156	1.427
Basketball experience * Minutes playing in game (xxxx)	.070	.582
Age * Basketball experience * Minutes playing in game (df=7; df error=54)	.192	1.832
Age * Games played (df=7; df error=54)	.065	.538
Basketball experience * Games played (df=7; df error=54)	.099	.849
Age * Basketball experience * Games played (df=7; df error=54)	.086	.730
Minutes playing in game* Games played (df=7; df error=54)	.088	.746
Age * Minutes playing in game* Games played (df=7; df error=54)	.061	.505

Legend: ** significant at $p<.01$ level * significant at $p<.05$ level

(Table 1). For standard situation-related parameters of efficiency, significant effects were found for total situation-related efficiency, position in the team, playing experience and time spent on the court in a game. For derived situation-related efficiency parameters, significant effects were found for total situation-related efficiency, position in the team and for their interaction.

When considering univariate effects, in total situation-related efficiency, statistically significant differences are found in the variables standard situation-related parameters: shots, assists, rebounds, steals, personal fouls, turnovers (the players with better total situational efficiency had higher scores). In the derived situation-related parameters, significant differences were found in the utilization

TABLE 2
SIGNIFICANT UNIVARIATE EFFECTS FOR TOTAL SITUATION-RELATED EFFICIENCY, POSITION IN THE TEAM AND THEIR INTERACTION (p<.01 level)

Dependent Variable	F-test	Total situation-related efficiency	X±SD	Dependent Variable	F-test	Position in team	X±SD
Standard parameters							
2FGM	66.460	Better	49.81±21.06	3FGM	30.624	Guards	15.49±8.44
		Worse	18.24±9.48			Forwards/centers	5.93±7.26
2FGA	36.873	Better	36.30±15.53	3FGA	15.770	Guards	28.13±15.20
		Worse	17.68±9.01			Forwards/centers	14.41±15.28
3FGM	8.074	Better	14.14±9.82	OREB*	17.327	Guards	9.51±7.40
		Worse	9.86±8.18			Forwards/centers	21.48±20.69
1FTM	30.884	Better	33.35±16.57	DREB	13.942	Guards	25.17±15.91
		Worse	14.89±9.06			Forwards/centers	41.70±20.69
1FTA*	8.284	Better	14.54±15.65	STL	7.097	Guards	15.55±8.21
		Worse	9.15±5.26			Forwards/centers	12.42±6.65
AST*	21.347	Better	30.89±22.42	AST*	17.327	Guards	27.45±21.74
		Worse	14.14±10.27			Forwards/centers	13.93±9.25
OREB*	23.603	Better	18.81±12.03	3FGUT	27.548	Guards	0.36±0.10
		Worse	8.95±6.06			Forwards/centers	0.22±0.18
DREB	43.495	Better	42.62±18.92	3FGEC	28.942	Guards	11.60±7.45
		Worse	19.78±11.71			Forwards/centers	4.02±5.39
STL	27.470	Better	18.46±6.84				
		Worse	10.43±6.53				
PF	12.439	Better	38.05±10.90				
		Worse	28.41±11.42				
TO	34.762	Better	27.84±11.22				
		Worse	14.95±7.82				
Derived parameters							
2FGUT	10.026	Better	0.58±0.07			Total situation-related efficiency * Position in team	
		Worse	0.50±0.11				
3FGUT	11.240	Better	0.34±0.14	3FGUT	5.469	Better-Guards	0.38±0.10
		Worse	0.28±0.16			Worse-Forwards/Centers	0.12±0.15
3FGEC	57.660	Better	10.97±8.88				
		Worse	6.71±5.59				
2FGEC	10.195	Better	58.53±28.36				
		Worse	19.22±11.71				
1FTEC	27.033	Better	24.06±12.75				
		Worse	10.99±6.88				

Legend: df=1, df error=70

2FGM = successful shots for two points; 2FGA = unsuccessful shots for two points; 3FGM = successful shots for three points; 3FGA = unsuccessful shots for three points; 1FTM = successful free throws; 1FTA = unsuccessful free throws; AST = assists; OREB = offensive rebounds; DREB = defensive rebounds; STL = steals; PF = personal fouls; TO = turnovers; 2FGUT = utilization coefficient for two-points shot; 3FGUT = utilization coefficient for three-points shot; 1FTC = utilization coefficient for free throws; 2FGEC = efficiency coefficient for two-point shots; 3FGEC = efficiency coefficient for three-point shot; 1FTEC = efficiency coefficient for free throws

and efficiency coefficients: the players with better total situational efficiency had higher scores. (Table 2). Significant differences depending on the position in the team were found in standard situation-related efficiency parameters connected with the shots for three points, steals and assists, and the players that play on the positions of guards had higher scores. Within differences in rebounds the players that played on the positions of forwards/centers had the higher scores. In the derived situation-related efficiency parameters, significant differences were found in:

TABLE 3
SIGNIFICANT UNIVARIATE EFFECTS FOR BASKETBALL EXPERIENCE AND TIME SPENT ON THE COURT DURING THE GAME (p<.01 level)

Dependent Variable	F-test	Basketball experience	X±SD
2FGM	5.655	Less	37.63±25.19
		More	26.96±14.84
		Minutes playing in game	
2FGM	6.623	Less	21.32±12.56
		More	46.73±23.58
2FGA	8.573	Less	17.51±8.59
		More	36.46±15.56
3FGM	7.139	Less	8.95±7.43
		More	15.05±9.92
3FGA	12.189	Less	15.41±11.42
		More	30.84±17.34
1FTM	5.395	Less	14.78±9.27
		More	33.46±16.33
DREB	8.958	Less	20.46±13.22
		More	41.95±18.73
STL	16.599	Less	9.14±5.55
		More	19.76±5.81
PF	6.437	Less	25.51±9.84
		More	40.95±8.81
TO	10.233	Less	14.03±6.64
		More	28.77±10.82

Legend: df=1, df error=70

2FGM = successful shots for two points; 2FGA = unsuccessful shots for two points; 3FGM = successful shots for three points; 3FGA = unsuccessful shots for three points; 1FTM = successful free throws; 1FTA = unsuccessful free throws; AST = assists; OREB = offensive rebounds; DREB = defensive rebounds; STL = steals; PF = personal fouls; TO = turnovers; 2FGUT = utilization coefficient for two-points shot; 3FGUT = utilization coefficient for three-points shot; 1FTC = utilization coefficient for free throws; 2FGEC = efficiency coefficient for two-point shots; 3FGEC = efficiency coefficient for three-point shot; 1FTEC = efficiency coefficient for free throws

utilization and efficiency coefficient for three-point shot, with the players that played on the positions of guards scoring the highest. One significant interaction between the total situation-related efficiency and position in the team was found in the utilization coefficient for three-points shot. It was found that the guards are those who have significantly higher coefficient for three-points shot. The players with higher scores in total situation-related efficiency had significantly higher values in the utilization coefficient for three-points shot in comparison with the players with the lower scores in the situation-related efficiency (Table 2).

Significant univariate effects for the playing experience are found only in one standard situation-related efficiency parameter (successful shots for two points): the players with longer playing experience have better scores. Significant univariate effects for time spent on the court in a game are found in nine standard situation-related efficiency parameters: shots, defensive rebounds, steals, personal fouls, turnovers. The players that spent more time on the court in the game have higher average values (Table 3). No differences have been found with respect to the players' age and the number of games played.

Discussion and Conclusions

The general main finding of this study has been expected from the previous research: the basketball players significantly differ in the standard situation-related efficiency parameters, according to their position within the team, total situation-related efficiency, time spent on the court in a game and the playing experience. On the other hand, basketball players in this sample significantly differ in the derived parameters of situation-related efficiency, according to their position within teams, total situation-related efficiency and in the interaction of those two factors. All the significant differences obtained confirm what has already been hypothesized in previously published studies[18,23]. The differences have not been found with respect to the players' age and the number of games played. These findings can be emphasized as unexpected, because the players' age can correspond with the playing experience and the number of games played can correspond with the time spent on the court. However, at the same time we must be aware that a large age range can be a cause of disproportion between these usually similar variables (age and experience), in terms of their correlations with other variables. Some players can start training basketball later, having previously practiced a different type of sport. On the other hand, injured players (who played a smaller number of games in the championship), can be important players for a team and spend proportionally more time on a court, than an average player.

For independent variable the position in the team, the results for all standard and derived situation-related efficiency parameters were in accordance with the hypothesis: shots for three points, steals and assists were performed more often by the guards, while forwards/centers performed more rebounds. However, one of the results has not been expected from the previous studies: regarding the total situation-related efficiency, in general, differences in all the standard and derived situation-related efficiency parameters were expected. Namely, the correlations between all the situation-related efficiency parameters and total situation-related efficiency were, in fact, spurious. The total situation-related efficiency is composed of all the standard situation-related efficiency parameters, as well as the derived ones. But, this presumption was not entirely fulfilled: the possible reasons for this fact could be different importance (ponder) of certain situation-related efficiency parameters, as well as their different frequency of occurrence during the basketball game (and during championship as a whole, as well).

Unsuccessful shots for three points cannot differentiate more and less successful players (more successful players have to take a risk to shoot for three points generally more frequently, with higher scores, but also with more unsuccessful shots). The similar explanation justifies the non-significant difference between more and less successful players in the coefficient of efficiency for three-points shot (this coefficient is highly influenced by the number of attempts which is an important factor in analyzing three-point shots). This can also explain the interaction of the variables total situation-related efficiency and the position in team in the coefficient of utilization for three-points shot. For the independent variable playing experience, higher scores in successful shots for two points in more experienced players were probably registered due to the, on average, very young sample of the subjects measured in the study (which can also diminish the negative implications of aging or burn-out). In such circumstances, more (in fact optimal) experienced players were, understandably, more constant in probably the most important standard situation-related efficiency parameter which is the successful shots for two points. In the study conducted by Nakić[33], similar results were found: in teams that participated in the European basketball championships, more successful teams were better in criteria of utilization and efficiency of two-points shot compared to the less successful teams. For the independent variable time spent on the court in a game the results showed that, in general, there are no differences between players that play more or less in the situation-related efficiency when measured with derived situation-related efficiency parameters. It is important to mention that the derived situation-related efficiency parameters are, in fact, better indicators of total situation-related efficiency when compared to the standard ones. It is not clear why there were no differences found in the unsuccessful shots for one point, offensive rebounds and assists, for players that play more and those that play less. Regarding the fact that the absolute (not relative) efficiency of the players who spent more or less time in play was analyzed, the assumption can be made that the players who played less are more efficient in two parameters (they could be highly motivated to affirm themselves through the offensive rebounds and assists) or less efficient (insufficiently warmed up and concentrated for shooting free throws), in comparison with the players who played more. In other words, players that spent less time on the court most probably are not lower quality players, with reserved place in the substitutes. They are more patient fighters waiting for their chance. Very important limitation when considering the differences in situation-related efficiency in the variables minutes spent on the court in a game and games played is the fact that pre-selection of the subject sample was made in these two variables, excluding the players that played less than ten minutes per game on average and the players that played less than eight games in the championship. Taking this into account, players that played less were more positively selected. However, the fact that the playing experience (not the player's age itself) caused the differences in performance (two point shots), as well as the non significant differences between the players that play more and less in the game (in offensive rebounds, assists, unsuccessful free throws), suggests the need for further research and coaches' interventions. In this aspect, further research can be directed towards deeper analysis of the influence of more complex differentiated variables playing experience and time spent on the court in a game on situation-related efficiency in basketball.

The main advantage of this study is the fact that the participants are top Croatian basketball players (all players included in the subject sample were A-1 Croatian basketball league players). One of the limitations of this research is probably the relatively small number of centers in the sample of basketball players, as well as their unequal distribution across the different teams. Another limitation of the study could be a certain particularity of the observed A-1 league season. Only nine teams were included in the championship (one team dropped out just before the championship), with a consequence that none of the teams could be relegated from the league, while only two teams competed for the first championship position: »Svjetlost« and »Cedevita«. Players from the seven remaining teams could play without any pressure, but also with unpredictably typical effort and consequent situation-related efficiency of each individual. The third limiting factor of the study was the pre-selection of the final sample of 74 players (according to the number of games played and time spent on the court in a game), which could impact on relatively low variability in the situation-related efficiency parameters. However, the players that were dropped out from the final sample were probably the less efficient ones[34].

Practical implications of these findings can be directed in the following directions. First, the specific type of players with »mixed« team positions can be trained (point guard-small forward, power forward-centre, etc.), and that type could be used only in specific phases of the game or during the whole game[34]. However, the information about determinants related to situation-related efficiency can help basketball coaches, especially at the A-1 Croatian basketball league level, to focus their work on the aspects with the highest importance and impact on the situation-related efficiency.

In other words, as expected, positions in the team, total situation-related efficiency and the total play time (time spent on the court in a game) were the most important determinants with respect to situation-related efficiency, but the level of importance of these factors varied from team to team. Future research could be directed more towards the use of probability models to forecast the performance of basketball players, as an excellent way to evaluate the future »portfolio assets« for the team, franchise, and business[16], adjusted to the level of sport performance quality (ranges of competition with different activity demands)[35]. The value of the player should be determined by using a combination of quantitative and complementary qualitative analysis, with all basic basketball metrics (situation-related efficiency parameters, as well as other methods)[34]. The best utility of such models is to update the model to stay current with player performance trends and monitor the warning signs as new information arrives[16]. The other direction is using new multiple-modality methods for extracting semantic information from basketball video: the visual, motion, and audio information can be extracted from video to first generate some low-level video segmentation and classification (Liu, Xu, Yi, Chia, & Rajan, 2006).

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POKAZATELJI USPJEŠNOSTI KOD VRHUNSKIH KOŠARKAŠA: ODNOSI S NEKOLIKO VARIJABLI

SAŽETAK

Cilj ovog istraživanja bio je utvrditi razlike u pokazateljima učinkovitosti seniorskih vrhunskih košarkaša, s obzirom na nekoliko nezavisnih varijabli: pozicija u momčadi, ukupna situacijska učinkovitost, dob, iskustvo igranja košarke te vrijeme provedeno na terenu na razini utakmice i za vrijeme trajanja prvenstvene sezone. Konačni uzorak sudionika je izabran iz svih momčadi u A-1 hrvatske muške košarkaške lige. Statistički značajne razlike pronađene su u odnosu na poziciju koju igrači igraju u momčadi, ukupnu situacijsku učinkovitost te za interakciju pozicija u momčadi / ukupna situacijska učinkovitost te broj minuta provedenih na terenu u igri / iskustvo igranja košarke. Razlike u situacijskoj učinkovitosti košarkaša nisu pronađeni u odnosu na dob košarkaša te broj odigranih utakmica u prvenstvu. Daljnja istraživanja mogu se usmjeriti na dublju analizu utjecaja raznovrsnije diferenciranih varijabli košarkaškog iskustva i vremena provedenog na parketu u igri na situacijsku učinkovitost u košarci.