ORIGINAL ARTICLE

Analysis of team sports results based on the European basketball men's championships

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Abstract

Introduction. The paper is a univariate study examining the performance in professional basketball. The authors did not include the influence of situational variables that affects the game dynamics thus the aim of the conducted study was the sole analysis of the point results obtained from selected basketball games. Aim of Study. The main topic of the study was the analysis of the impact of rule modifications on match results in men's professional basketball. Material and Methods. The research material consisted of numerical data on results of all matches played at men's European Basketball Championships between 1935 and 2015. All statistical calculations were carried out using the STATISTICA software package. Six main basketball rule modifications which directly affected the course of matches were identified in chronological order. Results. The results of the study showed that subsequent changes of basketball rules not always directly affected a match score. The number of scored points and allowed points following each consecutive rule modification since 1956 changed significantly. The greatest changes in match scores were noted after having introduced the modifications of basketball rules from 1956 and 1984. Conclusions. Rule modification involves processes that seek change in the game conditions, thus modifications in basketball should also be validated after following a reflective process. The main purposes of any future rule modifications in basketball should be to improve players performance, respond more efficiently to commercial pressures and interests, and finally attract more prospective players.

KEYWORDS: rules modification, sports tournament, performance analysis, team sports.

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Introduction

The present study uses the general theory of sports games, in particular, the theory of sports results. A sport result is based on a number of accumulated athlete's abilities developed in a long-term, conscious training process. The sports result is the ultimate manifestation of the athlete's biological abilities. It is determined by the athlete's innate predispositions, the natural, social environment and training. The concept of sport result should involve consideration of the athlete's talents, since their level of development is the most important from a social point of view.

Research studies on the dynamics of sports results, especially in team games, are usually based on simple analyses of these results [11, 13, 25]. Researchers of basketball statistics can be divided into two groups. The first group deals with standard indicators of situational efficiency. The other refers to works estimating various methods of assessment of basketball players during a game. Most often the assessment procedures use simple, one-factor models that ignore relations between numerous causal variables influencing the effect variable, i.e. the sports result.

Earlier studies on elite basketball games [6, 8, 9, 18, 23, 24, 29] tried to determine which game-related statistical

parameters discriminated between winning and defeated basketball teams. Other studies were aimed to find correlations between some game related parameters and win-loss record. Melnick [14] tried to find, based on five NBA seasons, a relationship between team assists and team success. There have been very few studies of rule modifications and little related information. Modifications of game rules cannot take place in the absence of objective knowledge that serves as a foundation for the decision [1, 2, 3, 10, 22, 30].

Rule modifications leading to better sports results in top-level basketball constitute an immensely important sports process determined by multiple factors. The precise identification and verification of these factors are indispensible for assessment of coaching activities. The proper understanding of the phenomenon of sports results requires the application of complex, analytical research methods [6, 8, 9, 15, 19, 24].

An important element of competition in the sports games are systems, rules and regulations of the competition, in which you are given the rules of conducting the competition, the rules for the classification of the teams by the results obtained and the principle of promotion to the next stages of the competition.

Monitoring of the basketball game is the discrete process, that including registration of successively occurring basketball matches action, but the transition from one action to another is done through dynamic structure created by the actions of the people directly affecting the situation in the game (players, referees). The obtained observation of the basketball game is used to compare projected strategy before the game with their actual implementation. This image is also used to control the game and make the resulting adjustments.

Key elements of team sports competitions include official rules and regulations determining the principles of competition, qualification of teams, elimination and promotion. Each team sport involves a specific methodology of calculation of sports result. In all team games, however, sports rivalry is translated into standings of teams or individual players according to their attained results. The sources of information and the contexts of attaining sports results in team games are presented in Table 1.

Along with the increasing worldwide popularity of basketball there have been multiple undertakings aimed at determining the organizational framework and position of basketball in the system of international sport organizations [4, 26, 27, 28, 29]. Modifying the rules is a common way to change game conditions. Since 1892 the rules of basketball have undergone many fundamental changes.

Since 1930 there are organized championship continents, which were initiated in South America. European countries inaugurated their championship, under the auspices of FIBA in Geneva (1935 − men) and in Rome (1938 − women). Rules of the game of basketball have essentially changed since 1892. To draw attention to the historical development of the game of basketball as a sport, and particularly to the significant changes in the rules of the game, a kind of paradigms that directly stimulate changes in the course of the game, are listed in the chronological order. The most important of them are:

− Rule Change 1 (since 1915): standardization of metal hoops with bottomless nets and backboards; setting the free-throw line at 4.5 m from the backboard; the rule that five players from each team may be on the court at one time, and that a player can be ejected after committing four fouls, a successful shot from the field of play awarded two points; the special purpose-built basketball replaced the hitherto used soccer ball; (since 1937) a jump ball is no longer used to resume play after a score.
− Rule Change 2 (since the Melbourne Olympic Games in 1956): introduction of the three-second rule and requirement to attempt a shot within 30 seconds of gaining possession.
− Rule Change 3 (since 1984): introduction of three-point shots from behind a 6.25 m line, longer dimensions of the basketball court; modifications of the 5- and 30-second rules; 7 team fouls in the quarter result in a "one-and-one" free throw.
− Rule Change 4 (since 1994): a basketball game became divided into two 20-min halves, or four 12-min quarters; introduction of two free throws after 7 team fouls in the half.
− Rule Change 5 (since 2000): a basketball game was divided into four 10-minute quarters; introduction of two free throws after 4 team fouls in the quarter; the requirement to advance the ball over the center line

Table 1. Sources of information about sports results

Registration and documentation of sports results	Contexts of attaining sports results during competitions
measuring equipment	game rules
documentation of sports events	level of sports event
information systems	organizational conditions
databases	geographical conditions
computer networks, Internet	

within ten seconds of gaining possession was reduced to 8 seconds; the weight of the official basketball was reduced for women's games.
− Rule Change 6 (since 2010): the three-point line was moved back to 6.75 m; the shape of the key changed from a trapezoid to a rectangle; introduction of the restricted area arc with a marginally wider radius of 1.25 metres; modifications of the 24-second rule; stricter penalties for fouls, especially for unsportsmanlike behavior; softer restrictions concerning travelling and illegal returning of the ball to the backcourt.

Each of the above rule modifications had affected, to various degrees, basketball games and their results. FIBA have continuously changed the rules to adjust to the evolution of how the game is played, adjusting to new situations that arises, helping the referees to officiate the game, trying to remove behaviours that are not in the spirit of the game and making the game more amusing for the spectators. Rule changes in basketball do not only counter emerging trends but can also play an active part on shaping the future development of how the game is played.

The aim of study was to characterize the dynamics of those changes at different stages of basketball development, in particular, with regard to basketball rules and regulations. Furthermore, gaining information on the development of tendencies in basketball can constitute a basis for programming the future evolution of sports results in this particular sport.

Material and Methods

Sample and procedures
The research material consisted of match scores in all Men's European Basketball Championships between 1935 and 2015, which is from the first championships in Switzerland in 1935 to the championships in four countries (Croatia, France, Latvia, Germany) in 2015. The data was gathered from the FIBA Europe website (www.fiba.com) and from reports by Ströher [28] and Małolepszy [12]. Physical performance in official competition was analysed for players in a professional basketball team that competed in the European Championships tournaments. The study was conducted according to the declaration of Helsinki, and was approved by the local ethics committee.

It is worth noticing that only 11 national teams took part in more than half of European Championships tournaments. They also included the Polish national team which played in 70.3% of championships. Data was gathered on the participation of all 45 national teams, including those from now defunct states.

Worthy of note is the fact that, taking into account the division meetings quarts and half see a relatively stable system the best countries − Spain, France, Russia and Italy, Yugoslavia, Czechoslovakia. These data illustrate a fairly stable sports level of European national basketball teams.

Data analysis
The statistical analysis involved a summary description of data using basic statistical methods, i.e. a deterministic approach. The description of the data set also used four groups of measures: measures of location, variation, asymmetry and concentration. For all parameters the following descriptive statistics were calculated: arithmetic means, medians, interquartile ranges, and standard deviations. All parameters were checked for their conformity to normal distribution. The conformity assessment was carried out with the Shapiro-Wilk test ($p < 0.05$).

Multi-factor analysis of variance (ANOVA) was used to compare the mean number of scored points (SP) and lost points (LP) for grouping variable: rule modification (Rule Change 1 – Rule Change 6). Initially, a complete statistical model was applied to examine all interactions. Next, non-significant interactions were excluded. The Kruskal-Wallis one-way ANOVA was used for significant differences between mean values. Also the post-hoc test for multiple comparisons was used. All statistical calculations were made using the STATISTICA 9.1. software package at the level of significance set at $p < 0.01$.

Results
Table 2 presents the basic descriptive statistics from 582 basketball games of the European basketball Championships (38 tournaments). The statistics were calculated for maximum 11 consecutive European Championship matches. Only in one case (2011 European Championships) did the Spanish national team play twelve consecutive tournament matches. Data in Table 2 shows that in the majority of cases the calculated parameters (mean − M, standard deviation − SD, median − Me) were better for tournament matches played after the division of match time into quarters. Also, the range between the largest and smallest values indicates smaller differences between the numbers of SP and LP in particular matches divided into quarters. On the other hand, the skewness and kurtosis values display only moderate deviations from zero; in the case of LP_11 they are moderately high. The variability of the results is particularly visible in ranges of

coefficients of variability from 7 to 19% (division into quarters) and from 19 to 36% (division into halves). These observations can be also made following a more detailed analysis of descriptive statistics for SP_1st half, SP_2nd half, LP_1st half and LP_2nd half of each of all 512 studied basketball games.

The division of a basketball game into quarters (Rule Change 5) was a determinant of a greater number of scored points in particular parts of matches of national teams during the European Championships. Not all of the six modifications of basketball rules differentiated the numbers of SP and LP. The obtained results reject the hypothesis of normal distribution of SP and LP, after the division of match time either into quarters or halves. There are differences between the mean values of SP and LP. A thorough analysis of distribution of results for SP revealed no extreme observations after any of the six rule changes, but merely some singular outlying observations. As for the number of LP, singular extreme observations and outliers were only noted in the aftermath of Rule Changes 1 and 2.

The number of scored points and lost points in all studied basketball games changed significantly after Rule Change 2 (p < 0.01) as indicated by the mean values of SP_1 – SP_10 and LP_1 − LP_10 (since 1957 – 10th European Basketball Championships).

Statistically significant differences were found in the number of LP in the majority of tournament matches

Table 2. Statistical data on scored and lost points in consecutive games of the men's European Basketball Championships

p/g	N		mean		p level		Me		min		max		range		SD		V		skewness		kurtosis	
	h	q	h	q	h	q	h	q	h	q	h	q	h	q	h	q	h	q	h	q	h	q
SP_1	408	104	68.4	75.4	1.0000	1.0000	71	77	9	50	126	99	117	49	22.09	10.44	32	14	−0.4	−0.2	0.1	−0.4
LP_1	408	104	68.2	75.4	1.0000	1.0000	70	77	6	50	126	99	120	49	22.54	10.39	33	14	−0.4	−0.2	0.1	−0.4
SP_2	408	104	68.2	76.9	1.0000	0.9334	71	76	0	49	123	114	123	65	23.17	14.40	34	19	−0.5	0.3	0.1	−0.4
LP_2	408	104	68.0	76.3	0.7731	0.6447	71	76	0	49	140	114	140	65	23.30	13.98	34	18	−0.3	0.4	0.3	−0.2
SP_3	408	104	67.2	75.3	0.4444	0.7253	68	75	7	50	140	106	133	56	22.43	11.54	33	15	−0.2	0.1	0.3	−0.2
LP_3	408	104	67.1	75.4	1.0000	0.7805	68	76	7	50	122	106	115	56	22.05	11.60	33	15	−0.3	0.0	−0.1	−0.2
SP_4	392	84	67.0	73.3	0.9865	0.0779	69	75	0	47	118	114	118	67	22.29	12.68	33	17	−0.4	0.3	0.0	0.3
LP_4	392	84	67.5	72.3	0.7712	0.0000	70	75	0	1	118	94	118	93	21.92	12.84	32	18	−0.5	−2.0	0.2	10.1
SP_5	384	72	69.6	76.2	0.3855	0.5948	71	76	0	47	122	102	122	55	21.29	11.29	31	15	−0.4	0.1	0.2	−0.2
LP_5	384	72	69.1	76.3	0.5638	0.1606	71	77	0	47	122	114	122	67	21.85	12.69	32	17	−0.4	0.2	0.1	0.4
SP_6	350	60	70.6	74.0	0.5753	0.3856	73	71	9	56	128	100	119	44	19.71	9.79	28	13	−0.5	0.7	0.2	0.1
LP_6	350	60	70.9	75.3	0.4762	1.0000	73	72	9	58	128	100	119	42	19.44	10.87	27	14	−0.3	0.7	0.0	−0.4
SP_7	316	40	71.9	75.1	0.0596	1.0000	72	73	0	55	119	99	119	44	19.44	11.10	27	15	−0.3	0.5	0.3	−0.6
LP_7	316	40	73.0	74.1	0.0546	0.5010	73	73	2	55	119	99	117	44	19.09	10.33	26	14	−0.3	0.5	0.3	−0.4
SP_8	207	27	70.8	73.7	0.0198	0.6614	70	74	2	56	120	96	118	40	17.95	10.30	25	14	0.0	0.4	0.3	−0.6
LP_8	207	27	69.8	74.6	0.0221	0.9760	69	74	0	59	120	96	120	37	18.33	10.55	26	14	−0.1	0.6	0.4	−0.6
SP_9	149	24	69.6	71.9	0.5107	0.5702	70	69	34	56	119	96	85	40	17.08	11.15	25	16	0.3	0.5	−0.2	−0.7
LP_9	149	24	69.2	70.6	0.2955	1.0000	67	69	25	56	119	89	94	33	16.34	9.91	24	14	0.5	0.2	0.3	−0.9
SP_10	54	8	59.4	76.8	0.3694	0.6204	60	78	25	69	90	86	65	17	13.13	5.70	22	7	−0.4	0.1	0.6	−0.8
LP_10	54	8	59.4	76.4	0.6039	0.5681	59	75	20	64	91	92	71	28	15.95	9.47	27	12	0.0	0.5	−0.1	−0.6
SP_11	10	6	66.9	76.3	0.3212		66	73	20	68	101	92	81	24	4.40	9.89	36	13	−0.4	1.0	0.5	−0.7
LP_11	10	6	75.7	76.5	0.5653		71	72	57	68	101	98	44	30	14.37	11.34	19	15	1.1	1.8	0.6	3.2

p/g – points per game, SP – scored points, LP – lost points, h – division of the game into halves, q – division of the game into quarters

(p < 0.05) between Rule Change 3 and Rule Change 4, and Rule Change 3 and Rule Change 2. This justifies the introduction of three-point shots and shot time regulations into official basketball rules. The rule modification introducing "one-to-one" free throws (change 3) also significantly affected the number of SP in the majority of matches (p < 0.01).

No statistically significant difference in the number of SP was found between Rule Change 4 and Rule Change 5 (p < 0.01). It can be concluded that the division of match time into 10-minute quarters did not differentiate significantly the number of SP.

As for lost points (LP) a statistically significant difference was noted in their number after the introduction

of Rule Changes 2 – 6. Thus each subsequent rule modification had an impact on the number of LP. The difference between Rule Change 3 and Rule Change 2 was statistically significant for the vast majority of LP (p < 0.01). A similar relationship was observed between Rule Changes 3 and 4. In the case of Rule Changes 3 and 4 the number of LP was significantly different in matches: LP_6, LP_7 and LP_8 (p < 0.01).

The comparison between mean numbers of SP and LP in all studied basketball games shows that the highest mean number of SP and LP was observed after the introduction of Rule Change 3 into the basketball rules (Figure 1, 2).
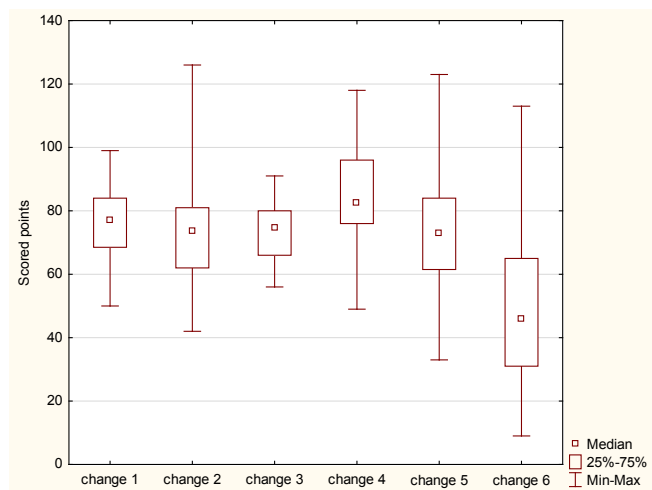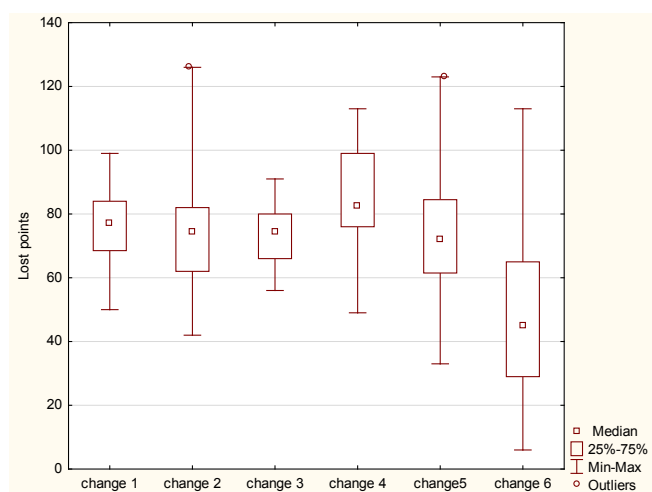
Discussion

The aim of this research was to estimate the importance of game rules in relation to the game scores during men's European Basketball Championships. The rules of basketball refer both to internal logic and external logic. The first type of rules can be structural and functional. Structural rules determine quantitative aspects of space, time, equipment and number of players. These aspects are static and establish the necessary conditions for executing game actions. Functional rules (qualitative rules) determine the form, use, and players' use of the structural elements, indicating obligations, rights, and prohibitions concerning space, time, equipment and relationships with other players. With regard to basketball players, a structural rule, for example, determines the number of players per team who can participate at the same time in the game space; whereas a functional rule indicates the constraints of body contact between players and the penalties, if they exceed these restrictions.

Rule modification involves processes that attempt to change the game conditions with a certain goal in mind. In 2000 FIBA changed the rules of basketball in Europe, their aim being to spot the offense more quickly so as to enhance the spectacularity of the game in order to increase television ratings and attract sponsors. In this way, the time allowed for offense was reduced from 10" to 8" seconds, and the maximum time allowed from the start of the offense until shooting the ball was reduced from 30" to 24"seconds. These changes in combination with the continuous improvement of defensive tactics significantly differentiated the way the offense was expressed.

Performance analysis in basketball is a fundamental tool for coaches, allowing them to obtain valid and reliable information concerning their team and opponents. Coaches and researchers use this information not only

Figure 1. Descriptive statistics for scored points (SP) and FIBA rule changes

Figure 2. Descriptive statistics for lost points (LP) and FIBA rule changes

to identify the most valuable players, but also the importance of certain specific roles [20] to evaluate the participation of starting players and substitutes. The aim is to determine how each player contributes to team performance [21] but also to assess the impact of rule changes [5].

The results of the present study show that subsequent changes in the official FIBA rules not always had a direct impact on sports results. The numbers of scored points and lost points changed significantly in the aftermath of modifications of basketball rules starting from 1956. A great impact on the pace of basketball games, and indirectly on the number of scored points had shot time restrictions and regulations on advancing the ball over the center line. Also evolutionary modifications of basketball rules significantly affected game tactics.

The greatest changes in game scores were noted following the introduction of Rule Changes 2 and 3. In particular, Rule Change 3 decidedly increased the number of scored and lost points in the matches under study. Similar observations were also made by Gomez et al. [7] and Ibáñez et al. [8]. On the other hand, men's teams display a higher game pace [16, 17]. This suggests better physical parameters permitting defense of higher intensity, more physical contact, and a game based on defensive rebounds to initiate ball possessions and fouls trying to stop the opponents' offense. Therefore, it is possible to distinguish two explanations for rule changes in basketball. The first is the need to modify the threshold of behavior disorders that occur during the game. The other is the need to develop game dynamics and motor skills that allow for improving the game over time.

All modifications of sports rules enhance game smoothness and improve the understanding and positive perception of games by spectators who want to see interesting matches. Rule modifications facilitate referees' work and help them solve contentious situations during the game. The changes of basketball rules are also aimed at an improvement of the game's spectacularity. Perhaps, greater time restrictions in basketball might be introduced in the future to make the game faster and more spectacular. The three-point line could be, for example, moved back a few centimeters, accounting for the ever greater development of basketball players' technique and skills.

Conclusions

This work may help to understand the implications of FIBA rule changes on the technical-tactical aspects of the basketball game. These findings can assist basketball coaches in adjusting practices and tactical

decisions to the new rules. It can also help sporting organisations understand the effects of this and therefore future rule modifications. Indicated aspects of the research allow for a more comprehensive look at the dynamics of the athletic performance in basketball, as well as the formulation of scientific principles for defining the rules for the match results in the team sports games. However, arbitrariness in the selection of the empirical data does not allow generalizing final conclusions substance. Therefore, spatially considering athletic basketball teams is limited to data for teams from Europe. Evaluation of the test results is even more important when the situation is recognized research involving comparisons between events championships in the different years.

The main conclusions of this article are:
− rule changes have mixed the effects on the spectacularity of the game; it increased the pace of the game and but reduced the scoring in the men European championship,
− the general trend towards a bigger proportion of the shots being 3-point field goals was temporarily reduced but no effect on the trend was made by the rule change.

This study was made on the European championships, which might not be fully representative for all kind of basketball leagues and levels. It analyses the game-related statistics, which although commonly used, only capture part of the performance in the basketball games.

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