RELATIONS AMONG VARIABLES OF SHOOTING FOR A GOAL AND OUTCOMES OF THE 2000 MEN'S EUROPEAN HANDBALL CHAMPIONSHIP MATCHES

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Abstract:

The goal of the research was to determine the relationships between variables of shooting for a goal and the final outcome of a handball match. The data were collected from 38 games of the 2000 Men's European Championship, played in Zagreb and Rijeka. Twelve indicators of the scoring efficiency, registered for each national team, constituted the sample of manifest variables, whereas the criterion variable was a binary outcome of a match - victory or defeat. The basic statistical procedures and regression analysis were used. Almost half of all the shots performed (44.61%) were executed from the back-court players' positions (field shots). The winning teams were considerably more efficient in field shots and in 7m throws than the defeated ones - (43.20%) and (76.53%) as compared to (32.52%) and (65.76%), respectively. The statistically significant multiple correlation of .71 means that the predictor variables share 50% of common variance with the final results of the observed matches. The winning teams had more successful field shots, 6m-centre shots and wing shots, and fewer unsuccessful 6m-centre and field shots and 7m throws. Scoring efficiency from a distance and from the 6m line differentiates the successful teams (winners) from the unsuccessful (defeated) ones.

Key words: *handball, scoring efficiency, match outcome, men*

BEZIEHUNGEN ZWISCHEN WURF-VARIABLEN UND ERGEBNISSEN DER HANDBALL-MATCHES BEI DER EUROPAMEISTERSCHAFT IM JAHRE 2000

Zusammenfassung:

Das Ziel dieser Studie war, die Beziehungen zwischen den Wurf-Variablen und Endergebnissen der Handball-Matches, festzstellen. Die Daten wurden den 38 Matches, die während der Europameisterschaft für Männer im Jahre 2000 in Zagreb und Rijeka gespielt wurden, entnommen. Zwölf Standardindexe der Torwurfeffizienz, die für jede Nationalmannschaft niedergeschrieben wurden, stellten die Gruppe von manifesten Variablen dar, wobei das Binarergebnis des Matches – Sieg oder Niederlage - die Kriteriumsvariable war. Sowohl die elementaren statistischen Verfahren als auch die Regressionsanalyse wurden durchgeführt. Fast die Hälfte aller Würfe aufs Tor (44.61%) wurden aus der Hinterfeld-Positionen durchgeführt. Bezüglich der aus der Hinterfeld-Positionen durchgeführten Würfe und bezüglich der Effizienz bei den 7-m-Würfen, waren die Sieger bedeutend mehr effizient als die besiegten Mannschaften, nämlich, 43,20% und 76,53% im Vergleich zu 32,52% und 65,76%. Die statistisch bedeutende vielfache Korrelation von 0,71 bedeutet, dass die Prediktorvariablen 50% der gemeinsamen Varianz mit dem Endresultat des beobachteten Matches geimeinsam haben. Die Sieger führten eine höhere Anzahl sowohl von erfolgreichen 9-m- und 6-m-Würfen als auch von Würfen von der Flügelposition durch. Sie führten auch eine kleinere Anzahl von unerfolgreichen 9-m-, 6-m- und 7-m-Würfen durch. Die Schusseffizienz bei den Fern- und 6-m-Würfen stellen diejenigen Indexe dar, die die erfolgreichen (Sieger) und unerfolgreichen (die Besiegten) Mannschaften voneinander unterscheiden.

Schlüsselwörter: *Handball, Schusseffizienz, Match-Resultat, Männer*

Introduction

Handball (team handball) belongs, from the aspect of movement structures and structures of game situations, to the group of polystructural complex sporting activities, characterized by typical and atypical game situations. A constant performance evaluation problem is the one concerning objective registration of separate game situations, that is, parameters of situation-related efficiency of individual players in a real, unpredictable, uncontrollable (from the aspect of measurement) environment of competition (Gréhaigne, Bouthier & Godbout, 1997).

The specific anthropological characteristics of players, as well as their fitness and preparedness are responsible for the successful performance of technical-tactical elements of the game, that is, for an efficient execution of the assigned tasks and jobs players have to accomplish during a match.

From the aspect of analysis of dimensions of athletes, it is possible to model a hierarchical structure of performance factors in team sports (Milanović, 1997), compounded of four groups of interrelated factors. The first level of the pyramid regards the basic anthropological characteristics, the second specific abilities and skills (knowledge) of handball players, whereas the third level comprises the situation-related indicators or performance of players, which can be obtained by registering events occurring during a game.

<table>
<tr><td colspan="2"></td><td colspan="3">OUTCOME OF A HANDBALL MATCH</td><td></td></tr>
<tr><td colspan="2">in the phase of defence</td><td colspan="2">on counterattack</td><td>in the phase of attack</td><td>on transition to defence</td></tr>
<tr><td colspan="6">SITUATION-RELATED OR PLAYING EFFICIENCY OF HANDBALL PLAYERS
(parameters of competition activites)</td></tr>
<tr><td>set of abilities responsible for specific physical conditioning fitness</td><td colspan="2">set of abilities and skills responsible for technical preparedness</td><td>set of abilities and skills responsible for tactical preparedness</td><td>theoretical preparedness</td><td>set of abilities and skills responsible for microsocial adaptation</td></tr>
<tr><td colspan="6">SPECIFIC ABILITIES AND SKILLS (KNOWLEDGE) OF HANDBALL PLAYERS</td></tr>
<tr><td>health status</td><td>morphological characteristics</td><td>basic functional abilities</td><td>basic motor (phyical) abilities)</td><td>cognitive (intellectual) abilities</td><td>conative abilities</td></tr>
<tr><td colspan="6">BASIC ANTHROPOLOGICAL CHARACTERISTICS</td></tr>
</table>

Figure 1. Hierarchical structure of performance (success) factors in handball (modified according to Milanović, 1997).

Observation of a handball match and appropriately kept records of actions occurring during a match allow us to obtain indicators of situation-related efficiency during the game flow (in four phases of the game: set defence, fast break, set attack and transition to defence), as well as parameters of tactical responsibility, of players' engagement in a game, their general behaviour and many others. Each handball game offers plenty of opportunities for registering large amounts of data (about types and quality of actions performed by individual players and the whole teams), which can then be interpreted. Research on performance parameters should eventually enable a prognosis or prediction of the final outcome of handball matches.

For quite a long time now the evaluation of performance indicators has attracted considerable interest of experts in the area of applied kinesiology (kinesiology of sport) or sports sciences. Sporting games are rich sources of opportunities for the registration of technical – tactical elements of the game due to their dual nature - relationships of cooperation among the teammates and of confrontation among players pertaining to the adversary teams who strive for the same goal, to win, cause and maintain constant dynamics of the game flow. Such relationships are responsible for all the abundance of mostly unpredictable game situations (Gréhaigne, Bouthier & Godbout, 1997).

One of the fundamental issues in the research on team ball games is how to objectively measure and get unbiased data about the partial and overall performance of individual players and teams. Gréhaigne, Bouthier and Godbout (1997) proposed an original procedure for assessing the players' performance in attack play for various team sports (basketball, handball, football, volleyball, rugby). They have defined two derived indicators: the efficiency index and the volume of play. A combination of these two indicators enables an insight into the authentic playing efficiency based on the observation of the players' attack actions during matches.

Several research studies on basketball games (Trninić, 1995; Jukić et al., 2000; Dežman & Tkalčić, 2002) were oriented to an assessment of

particular parameters which undoubtedly contribute to a better understanding of the performance measurement and evaluation issues. Trninić and associates (1995) and Dizdar and associates (1997) have defined, on the basis of situation-related variables, types of players and their roles, thus confirming the practical experience of basketball experts. With a series of research Swalgin (1994, 1998) has contributed considerably to the scientific approach to analysis and evaluation of position-related performance of basketball players. He conducted a longitudinal study with top-level USA basketballers and established national performance norms based on the criteria: position of play and minutes played.

A somewhat smaller number of research studies dealt with the evaluation of situation-related parameters in other sport games. Research studies with top-level volleyball (Janković, Marelić, & Milanović, 1991; Marelić, 1994; Marelić, Žufar, & Omrčen, 1998), football (Jerković & Barišić 1997) and water polo teams (Šimenc, Silić, & Vuleta, 1997; Šimenc et al., 2003) revealed that the observed situation-related parameters are closely related to playing efficiency and the final outcome of a game.

Statistical records of performance of both individual players and teams have been introduced into handball later than was the case with the rest of team sports (e.g. basketball or volleyball). Existing research on various aspects of performance in handball can be classified into three groups. The first group consists of works that descriptively analyse the frequency of various game events, that is the successfulness of various technical-tactical elements implementation.

Vuleta and Šimenc (1989) analysed certain indicators of play efficiency demonstrated by the Croatian national team at the VIIth Junior World Championship (16 participants and 62 matches played). The findings were as follows:

- The Croatian national team scored a total of 176 goals, 25.1 on average per game;
- Conceded a total of 158 goals, or 22.5 on average;
- Attempted a total of 288 shots at the goal, out of which 176 were successful, which is scoring efficiency of 61.1% per match.
- The most goals were scored from the pivot position (6m centre) - 47 (shots taken from a fast break included since they were performed from the 6m line), and from the position of the centre back-court player.
- The lowest efficiency was registered for the right wing position – only 10 goals scored.

On the sample of 14 male handball players of one team Šimenc, Vuleta and associates (1996) investigated the individual and team play efficiency on attack and on defence by employing a battery of 18 variables. The findings were as follows:

- The most efficient playing position was that of the back-court players both on attack (52% out of the total team scores) and on defence (a considerable number of balls gained and blocked away).
- The second best group were goalkeepers (45.7%). Out of the total of shots at their goal (448), they concede 243 goals scored or 54.3% - 49 goals (20%) from the pivot position, 37 (15.2%) 7m throws, and the fewest, 22 goals (9%), from the right wing position. They had 205 saves – most saved balls were long distance shots: 48 shots (23.4%) taken from the position of the left back-court player and 34 (16.5%) from the position of the centre back-court player, whereas they saved the fewest shots (17, or 18.2%) from the 7m line.
- The third group consisted of the wingers, efficiency of which was estimated at 28%.
- The pivots constituted the fourth group with an underaverage efficiency of 19%.
- The most technical faults (98) were made by the whole team in the attacking phase of the game; out of the total number of faults, 55 (or 56%) were inaccurate passes.

The second orientation in research on handball performance addresses the differences between handball teams classified according to various criteria (winners or losers, final placement at the end of any official competition and others).

Brčić and associates (1997) tested the predictive value of a set of 43 variables, designed for the evaluation of execution of handball technical-tactical elements, on a sample of 91 handball matches of the Croatian Championship 1st League for women in the 1995/96 competition season. Twelve teams were classified in three qualitative groups according to the final placement at the end of the season. The basic parameters of the variables within each qualitative group of teams were determined, as well as the parameters for the entire sample of teams. A three-way factor analysis of variance (MANOVA) was applied in order to determine the predictive power of the play indicators to discriminate between the teams according to the following criteria: the teams pertaining to different qualitative groups, the opposing teams pertaining to different qualitative groups and the play of the home/visiting teams. It was established that the constructed battery of 43 variables successfully discriminated between the

matches of teams pertaining to different qualitative categories of the teams, matches of the opposing teams pertaining to different qualitative categories of opponents, and matches played at home and away. However, the differences in play among the teams of different qualitative categories and the opposing teams of different qualitative categories were not established. No differences in play were found among teams of different qualitative categories when playing matches at home or away, neither were the differences proved among the opposing teams differently categorized when playing at home or away. No interactions among all three classification variables were established.

Probably the most important scientific issue is the one regarding the determination of influence various situation-related variables have on the final outcome of a match. Various samples of registered indicators of performance on attack and defence may serve as predictor variables, whereas a criterion variable may be presented by a victory or defeat in the observed match.

On a sample of 80 matches, played at the 1999 Men's World Handball Championship in Egypt, Rogulj (2000) determined the differences in the performance parameters (27) of play in attack and defence by means of multivariate analysis of variance. These 27 performance indicators have been analysed in relation to the level of success or competitive successfulness which was determined by two classification factors: general championship performance (defined by the final placement of teams) and performance in a match (defined by a victory or defeat in a match). Statistically significant differences were obtained in both classification factors. Scoring performance can be best described in terms of efficient conduction of collective fast breaks, efficient completion of the position attacks against an organized defence, particularly by the penalty throw and individual breakthrough, then in terms of efficient execution of non-contact elements of defence, a small number of technical faults in attack play, as well as in terms of the goalkeeper's performance in saving the field shot balls.

Srhoj and associates (2001*)* used the sample of 80 matches, played at the 1999 Men's World Handball Championship in Egypt, to determine the significance of position-related closing attacking actions and influence of the 18 prediction variables on the final match result. All but one (the position of a circle runner/pivot) variables of successful shooting for a goal (scoring efficiency) have significant influence on the outcome of a handball match. Particularly significant were the variables of field shooting (backcourt positions), individual breakthrough shots and fast break shots. Variables connected with the frequency of shooting from various positions (locations) on the court had no significant influence on the outcome of matches, meaning that sport achievement (victory) does not depend on the quantity, but on the quality of shoting at goal.

The present research investigates technical – tactical activities in handball, thus contributing to an enhanced understanding of their importance in the game. However, not all situation-related indicators of playing efficiency are always equally important for the final match outcome. Namely, various indicators of efficiency in defence and attack have a variable influence on the final game result. Therefore, the goal of the study was to determine the relationships between typical indicators of the scoring efficiency and the final result of top-level handball matches played at the 2000 Men's European Championship.

Methods

Sample of entitites

The data were collected by trained EHF observers at the 38 matches of the 4th Men's European Handball Championship, held in Zagreb and Rijeka, Croatia, on January 21- 30, 2000. The sample of entities consisted of twelve national teams:

Group A		Group B	
1. Spain	**ESP**	1. Russia	**RUS**
2. Germany	**GER**	2. Sweden	**SWE**
3. France	**FRA**	3. Portugal	**POR**
4. Croatia	**CRO**	4. Denmark	**DEN**
5. Norway	**NOR**	5. Slovenia	**SLO**
6. Ukraine	**UKR**	6. Island	**ISL**

Sample of variables

The sample of manifest variables consisted of 12 standard indicators of the scoring efficiency registered for each team in a match:

1. 7m throws - made (**7MTM)**
2. 7m throws - missed (**7MTmiss)**
3. 6m-centre shots (the pivot player position) - made (**6MCSHM)**
4. 6m-centre shots (the pivot player position) - missed (**6MCSHmiss)**
5. Wing shots **(**taken from the wing positions) - made (**WSHM)**
6. Wing shots (taken from the wing positions) - missed (**WSHmiss)**

7. Field shots (taken from the back-court player positions) – made (**FSHM)**
8. Field shots (taken from the back-court player positions) - missed (**FSHmiss)**
9. Fast break shots (taken from a counterattack) - made (**FBSHM)**
10. Fast break shots (taken from a counterattack) - missed (**FBSHmiss)**
11. Breakthrough shots (taken from a breakthrough) - made (**BTSHM)**
12. Breakthrough shots (taken from a breakthrough) - missed (**BTSHmiss)**

The criterion variable is a binary one defined on the basis of the final outcomes of the handball matches played – **VICTORY (WON)/DEFEAT (DEFEAT)**.

Data processing methods

Basic statistical parameters for each and every shooting and scoring datum were computed, as well as the coefficients of correlation among the predictor variables. Multiple regression analysis (STATISTICA FOR WINDOWS, release 5.0) was utilized to establish the predictive power of the variables of shooting for a goal, successful and unsuccessful, in relation to the binary defined criterion variable – outcome of a game. It should reveal a potential of the scoring efficiency for predicting the final outcome of a match.

The following was computed:

- Basic statistical parameters: mean (MEAN), standard deviation (SD), the lowest value (MIN), the highest value (MAX) and variance;
- Matrix of correlations among the predictor variables of successful and unsuccessful goal shots;
- Within classical regression analysis the following was computed:
  - Multiple correlation and coefficient of determination (RO and RO^2);
  - Standard error of estimate (Std. Err.);
  - Standard regression coefficients of the predictor variables (BETA);
  - Nonstandard regression coefficients of the predictor variables (B);
  - Values of F–test, assessing the statistical significance of multiple correlation (F);
  - Level of significance of the multiple correlation coefficient - probability of the hypothesis that the multiple correlation equals zero (p);
  - Standard errors of standard regression coefficients of the predictor variables (St. Err.of BETA);
  - Standard errors of nonstandard regression coefficients (St. Err.of B);
  - Value of *t*–test, assessing the statistical significance of the regression coefficients (t)
  - Level of significance of regression coefficients – probability of the hypothesis that the regression coefficients are zero (p-level).

Results and discussion

Actual results of the competition

PRELIMINARY MATCHES WITHIN THE GROUPS

GROUP A

Match No.	Teams	Results
1.	**ESP : CRO**	27:22
3.	**GER : UKR**	24:24
5.	**FRA : NOR**	24:21
7.	**CRO : GER**	21:20
9.	**NOR : ESP**	21:25
11.	**UKR : FRA**	22:24
13.	**ESP : UKR**	27:24
15.	**GER : FRA**	19:25
17.	**CRO : NOR**	27:23
19.	**GER : NOR**	22:22
21.	**FRA : ESP**	28:22
23.	**UKR : CRO**	18:26
25.	**NOR : UKR**	19:16
27.	**FRA : CRO**	26:26
29.	**ESP : GER**	27:25

GROUP B

Match No.	Teams	Results
2.	**RUS : DEN**	27:26
4.	**SWE : ISL**	31:23
6.	**POR : SLO**	28:27
8.	**DEN : SWE**	22:29
10.	**SLO : RUS**	23:27
12.	**ISL : POR**	25:28
14.	**RUS : ISL**	25:23
16.	**SWE : POR**	29:21
18.	**DEN : SLO**	24:28
20.	**SWE : POR**	26:24
22.	**POR : RUS**	20:24
24.	**ISL : DEN**	24:26
26.	**SLO : ISL**	27:26
28.	**POR : DEN**	26:28
30.	**RUS : SWE**	25:28

STANDING WITHIN THE GROUPS

GROUP A

	Games	Won	Draw	Lost	Goal difference	Points
1. FRA	5	4	1	0	127:110 +17	9
2. ESP	5	4	0	1	128:120 +8	8
3. CRO	5	3	1	1	122:114 +8	7
4. NOR	5	1	1	3	106:114 -8	3
5. GER	5	0	2	3	110:119 -9	2
6. UKR	5	0	1	4	104:120 -16	1

GROUP B

	Games	Won	Draw	Lost	Goal difference	Points
1. SWE	5	5	0	0	143:115 +28	10
2. RUS	5	4	0	1	128:120 +8	8
3. SLO	5	2	0	3	129:131 -2	4
4. POR	5	2	0	3	123:133 -10	4
5. DEN	5	2	0	3	126:134 -8	4
6. ISL	5	0	0	5	121:137 -18	0

The most efficient team of Group A was Spain with 128 goals scored (25.6 on average); the second best was France, which was placed first in the group, with 127 goals scored (25.4 on average); and the third was Croatia with 122 goals scored (24.4 on average).

France conceded the fewest goals – 110, or 22 on average. Spain and Ukraine, the second and the last team in the group, received the largest number of goals - 120, or 24 on average per game. Nevertheless, Spain was second in the group because it was the group's most efficient team in goal scoring.

Sweden, the most efficient team in Group B, with 143 goals scored, or 28.6 on average, and the most successful team on defence – conceded the fewest goals - 115, or 23 on average, was placed first in the group. The second best in efficacy was Slovenia, with 129 goals scored, or 25.8 on average, and third was Russia with 128 goals, or 25.6 per match.

The team of Island, which received the most goals - 137, or 27.4 on average, was the least efficient – they scored only 121 goals, or 24.2 on average, and was placed last in the group.

FINAL RANKING

1. SWE	Sweden
2. RUS	Russia
3. ESP	Spain
4. FRA	France
5. SLO	Slovenia
6. CRO	Croatia
7. POR	Portugal
8. NOR	Norway
9. GER	Germany
10. DEN	Denmark
11. ISL	Island
12. UKR	Ukraine

The first placed teams in both groups – France and Sweden, conceded the fewest goals in the five group matches. On attack, Sweden was the far most efficient team in the first part of the 4th European Championship.

It is interesting that the world champion, Sweden, the most efficient team in the group with the scoring average of 28.6 goals per game, scored 24 goals in the final match during the regular time, or 32 goals altogether in the entire match with two extensions (4x5), whereas Russia scored 31 goals.

France beat Spain (24:23) in the third-place match.

It can be concluded from the aforementioned data that the average of 25 goals scored per game, or a goal scored every 2.4 minutes by one of the rivals in a match, is a characteristic indicator of the scoring efficiency of the top-level teams that participated in the 4th Men's European Handball Championship.

RESULTS OF THE PLACEMENT MATCHES

Match No.	Team	Results	Placement
31	**UKR : ISL**	25:26	11/12
32	**GER : DEN**	19:17	9/10
33	**NOR : POR**	27:30	7/8
34	**CRO : SLO**	24:25	5/6
35	**FRA : RUS**	23:30	semi-final 1
36	**SWE : ESP**	23:21	semi-final 2
37	**ESP : FRA**	24:23	3/4
38	**RUS : SWE**	31:32	1/2

Analysis of central and dispersive parameters of the predictor variables

Table 1. Total basic statistical indicators of scoring efficiency

VARIABLES	MEAN	MIN	MAX	SD
7MTM	3.38	0.00	8.00	1.77
7MTmiss	1.36	0.00	5.00	1.25
6MSHM	4.46	0.00	11.00	2.28
6MSHmiss	1.62	0.00	8.00	1.57
SSHM	3.64	0.00	9.00	2.11
SSHmiss	3.38	0.00	9.00	1.77
FSHM	7.55	1.00	15.00	3.18
FSHmiss	12.80	4.00	26.00	4.57
FBSHM	3.46	0.00	9.00	2.24
FBSHmiss	1.28	0.00	6.00	1.43
BTSHM	2.07	0.00	7.00	1.55
BTSHmiss	0.62	0.00	3.00	0.88

Legend: 7MTM – 7m throws - made; 7MTmiss - 7m throws - missed; 6MCSHM – 6m-centre shots - made; 6MCSHmiss – 6m-centre shots - missed; WSHM –wing shots – made; WSHmiss – wing shots – missed; FSHM – field shots - made; FSHmiss – field shots - missed; FBSHM – fast break shots – made; FBSHmiss – fast break shots – missed; BTSHM - breakthrough shots – made; BTSHmiss - breakthrough shots - missed

Total indicators of scoring efficiency of both the winners and of the defeated teams are summed up in Table 1. The highest average frequency of occurrence was registered for the variable field shot – missed (FSHmiss) - 12.8 per game, followed by the variable field shot – made (FSHM) - 7.55 per game. It should be stressed here that 44.61% of the total goal shots were taken from the back-court positions.

A relatively wide range between the minimal and maximal results is obvious, which speaks in favour of the variables being sensitive enough. The finding is corroborated by the fact that about 4.5 standard deviations occur most frequently in the interval between the highest and the lowest result. The least sensitive variables were the breakthrough shots – missed (BTSHmiss) and 7m throws – missed (7MTmiss), whereas the greatest sensitivity was registered for the variables 6m-centre shots – missed (6MCSHmiss) and wing shots – missed (WSHmiss).

For the theory and practice of handball the following may be very useful - the ratio between successful and unsuccessful realization of shots at the goal taken from different positions reveals that players were most efficient when shooting from a breakthrough (76.95%), then came, in descending order, shots taken from the 6m line (73.36%), from a counterattack (73 %), and from the 7m line (71.3%). Considerably poorer was the scoring efficiency from the wing positions (51.85%), whereas goal shots taken from the back-court positions were the least successful (37.1%). Efficiency in the last two variables is below the expected level of efficiency for a prominent competition such is the European championship. Namely, the expected efficency level of back-court and wing shots is about 50% and 60%, respectively (Czerwinski, 1998 and 2000; Seco, 2001).

In Table 2 the basic descriptive parameters of goal shots are displayed separately for the winning and defeated teams.

Table 2. Basic statistical parameters of scoring efficiency for the winning and the defeated teams

VARIABLES	MEAN WINN	MEAN DEFEAT	MIN WINN	MIN DEFEAT	MAX WINN	MAX DEFEAT	SD WINN	SD DEFEAT
7MTM	3.26	3.40	0.00	0.00	6.00	8.00	1.62	1.88
7MTmiss	1.00	1.77	0.00	0.00	3.00	5.00	0.91	1.50
6MSHM	4.91	4.00	1.00	0.00	10.00	11.00	2.20	2.44
6MSHmiss	1.63	1.71	0.00	0.00	8.00	5.00	1.77	1.47
SSHM	4.11	3.20	0.00	0.00	8.00	9.00	1.95	2.11
SSHmiss	3.40	3.49	1.00	0.00	7.00	9.00	1.50	2.01
FSHM	8.26	6.94	1.00	1.00	15.00	13.00	3.64	2.63
FSHmiss	10.86	14.4	4.00	6.00	18.00	26.00	3.45	4.83
FBSHM	3.66	3.31	0.00	0.00	9.00	9.00	2.38	2.23
FBSHmiss	1.29	1.26	0.00	0.00	6.00	5.00	1.56	1.38
BTSHM	2.09	2.09	0.00	0.00	7.00	6.00	1.72	1.34
BTSHmiss	0.69	0.63	0.00	0.00	3.00	3.00	0.87	0.94

Legend: 7MTM – 7m throws - made; 7MTmiss - 7m throws - missed; 6MCSHM – 6m-centre shots - made; 6MCSHmiss – 6m-centre shots - missed; WSHM –wing shots – made; WSHmiss – wing shots – missed; FSHM – field shots - made; FSHmiss – field shots - missed; FBSHM – fast break shots – made; FBSHmiss – fast break shots – missed; BTSHM - breakthrough shots – made; BTSHmiss - breakthrough shots - missed

Even at the level of average values, certain numerical differences among the observed teams are obvious. It is interesting that, on average, the defeated teams performed more shots at the goal from a distance per match (back-court players' positions - 21.34) than the winning teams (19.12). The winning teams performed more goal shots of different types, especially from the 6m line, the wing positions and from a fast break. It speaks in favour of a variety of diverse modes of tactical activity in attack performed by the victorious teams (Czerwinski, 1998, 2000; Seco, 2001).

The winning teams had better scoring efficiency in all but one variable – breakthrough shots. The scoring efficiency of the winning teams in long distance shots was 43.20% as compared to the percentage of the defeated teams of 32.52%. Then, in 7m throws the efficiency of the winners was 76.53% vs. 65.76% of the defeated; in the wing shots 54.73% vs. 47.83%; and in the 6m-centre shots 75.08% vs. 70.05% in favour of the winners. The scoring efficiency of shots taken from fasbreaks was almost the same.

Intercorrelation of the predictor variables

In Table 3 the correlations of variables of shooting for a goal for all the observed teams are presented. It can be concluded that out of the total of 66 correlation coefficients, only 4 of them, or 7%, were significant at the level of 0.01. Although 16 of them, or 23%, were significant at the level of 0.05, in this paper we will analyse only the correlation coefficients which meet the significance criterion of 99%. The fact that all four significant correlation coefficients have a negative sign and that they are slightly above the limit of statistical significance (-.30 to -.36) indicates a mild negative relationship among the several typical variables of shooting for a goal.

The largest negative correlation (-.36) was obtained between the variables field shots – missed (FSHmiss) and wing shots - made (WSHM). The rest of the three significant negative correlations were obtained between the variables fast break shots – made (FBSHM) and field shots - missed (FSHmiss) (-.33), then between field shots - made (FSHM) and 6m-centre shots - made (6MCSHM) (-.31), and between breakthrough shots – made (BTSHM) and field shots - missed (FSHmiss) (-.30).

On the basis of the obtained measures of negative correlations it can be concluded that the prevailance of variables of shooting from a distance, either made or missed, means fewer occurrences of some other types of shooting, that is, shots taken either from the wing or the pivot position, or from a breakthrough. As far as tactics is concerned, teams usually apply one of the two possible models of finishing the attack actions – either by long distance shots or from the 6m line.

In Table 4 the relations among the variables of shooting for a goal in the victorious (beneath the great diagonale) and in the defeated (above the great diagonale) teams are presented.

Within the group of winning teams, out of the total of 66 correlation coefficients, only 11 of them are statistically significant (17%) at the level of 0.01. Out of these, eight have a negative sign and range within the interval from -.33 to -.56, whereas three positive correlation coefficients range from .33 to .48. The greatest negative correlation coefficient (-.56) was obtained between the

Table 3. Matrix of intercorrelations among the predictor variables

	7MTM	7MTmiss	6MSHM	6MSHmiss	SSHM	SSHmiss	FSHM	FSHmiss	FBSHM	FBSHmiss	BTSHM	BTSHmiss
7MTM	1.00											
7MTmiss	0.03	1.00										
6MSHM	0.03	0.12	1.00									
6MSHmiss	0.25	-0.03	0.04	1.00								
SSHM	-0.01	0.00	0.01	0.18	1.00							
SSHmiss	0.16	0.05	0.16	-0.02	0.22	1.00						
FSHM	-0.28	-0.01	**-0.31**	-0.28	-0.26	-0.18	1.00					
FSHmiss	-0.09	0.09	-0.06	-0.12	**-0.36**	-0.26	0.14	1.00				
FBSHM	-0.17	-0.06	0.11	-0.03	-0.10	0.09	**-0.33**	0.01	1.00			
FBSHmiss	0.01	-0.15	0.28	0.02	-0.12	0.08	-0.22	-0.15	0.23	1.00		
BTSHM	-0.15	-0.12	-0.03	0.01	0.12	0.06	-0.22	**-0.30**	-0.04	0.02	1.00	
BTSHmiss	-0.04	0.04	0.18	0.16	0.12	-0.06	-0.14	-0.22	0.01	0.05	0.29	1.00

Legend: 7MTM – 7m throws - made; 7MTmiss - 7m throws - missed; 6MCSHM – 6m-centre shots - made; 6MCSHmiss – 6m-centre shots - missed; WSHM –wing shots – made; WSHmiss – wing shots – missed; FSHM – field shots - made; FSHmiss – field shots - missed; FBSHM – fast break shots – made; FBSHmiss – fast break shots – missed; BTSHM - breakthrough shots – made; BTSHmiss - breakthrough shots - missed

variable fast break shots – made (FBSHM) and the variables field shot - made (FSHM) and field shot– missed (FSHmiss).

The obtained correlation coefficients revealed specific relations between the variables of shots taken outside the 9-meter line, both made and missed, on the one hand, and all the rest of the variables of shooting at the goal – the fast break, 6m-line, wing, and breakthrough shots, on the other. These negative relations can be explained as follows: if a team choose such a style of play in which the players close their attack actions primarily by distance shots, they will consequently realize fewer goal shots from other positions. The model of play in which distance shots prevail may be determined by a superiority of the winning teams.

In the group of winners the significant positive relations were obtained between the variables fast break shots – missed (FBSHmiss) and 6m-centre shots – made (6MCSHM) (.48) and fast break shots – made (FBSHM) (.40), and between the variables breakthrough shots – made (BTSHM) and breakthrough shots – missed (BTSHmiss) (.33).

Although these relations are somewhat unexpected, we can state that in the background of these relations almost equal dispersions of the winning teams in the successfully realized variables of shots taken from a counterattack and from a breakthrough can be found.

It seems that much the same frequency of successful and unsuccessful conclusions of the attack actions performed by all the winners lies in the base of the unexpected positive correlations.

Within the group of the defeated teams, out of the total of 66 correlation coefficients, only 17 of them are statistically significant (26%) at the level of 0.01. Out of these, eleven have a negative sign and range within the interval from -.30 to -.50, whereas six positive correlation coefficients range from .31 to .47.

The greatest negative correlation (-.50) was obtained between the variables wing shots - made (WSHM) and field shots - missed (FSHmiss). Somewhat lower, but still moderately high negative correlation (-.47) was obtained between the variables wing shots - missed (WSHmiss) and field shots - made (FSHM). Analysis of the greatest negative correlations suggests that the defeated teams' concept of play was to finish their attacks from the wing positions when they were not successful from the back-court positions. Or, when they were efficient from a distance, fewer balls were available for the wings, that is they had fewer opportunities to miss a goal shot.

A somewhat lower negative correlation (-.45) was obtained for the variables 6m-centre shots - missed (6MCSHmiss) and field shots – made (FSHM). The finding indicates that the defeated teams, if they had good back-court players, preferred to finish their attack actions more frequently from distance and seldom from the 6m line (the position of a pivot).

The greatest positive correlation (.47) was obtained between the variables field shots – missed (FSHmiss) and fast break shots – made (FBSHM). A somewhat lower correlation (.46) was obtained between the variables 7m throws – made (7MTM) and 6m-centre shots – missed

Table 4. Intercorrelations of predictor variables in the victorious (above the great diagonale) and in the defeated (under the great diagonale) teams

	7MTM	7MTmiss	6MSHM	6MSHmiss	SSHM	SSHmiss	FSHM	FSHmiss	FBSHM	FBSHmiss	BTSHM	BTSHmiss
7MTM	**1.00**	0.00	-0.10	**0.46**	0.21	0.23	**-0.36**	-0.20	-0.20	0.05	0.03	0.05
7MTmiss	0.16	**1.00**	**0.39**	-0.15	0.00	0.01	0.00	0.08	-0.08	-0.17	**-0.30**	0.06
6MSHM	0.21	-0.15	**1.00**	0.24	0.06	0.15	**-0.36**	0.04	-0.05	0.06	0.08	0.29
6MSHmiss	0.12	0.07	-0.11	**1.00**	0.17	0.21	**-0.45**	**-0.38**	-0.19	**0.34**	0.19	0.26
SSHM	-0.04	0.15	-0.08	0.24	**1.00**	**-0.37**	**-0.44**	**-0.50**	**-0.36**	-0.24	0.19	0.22
SSHmiss	0.19	0.09	0.21	-0.23	-0.02	**1.00**	**-0.47**	-0.27	0.07	0.01	0.17	0.07
FSHM	-.025	0.17	**-0.38**	-0.18	**-0.37**	-0.01	**1.00**	**0.34**	0.01	-0.06	-0.21	-0.19
FSHmiss	-0.04	-0.24	0.02	0.05	-0.15	-0.13	0.29	**1.00**	**0.47**	-0.13	**-0.33**	-0.12
FBSHM	-0.08	-0.04	0.26	0.05	0.08	0.16	**-0.56**	**-0.56**	**1.00**	0.06	-0.29	-0.08
FBSHmiss	-0.04	-0.12	**0.48**	-0.21	0.05	0.21	**-0.35**	-0.22	**0.40**	**1.00**	-0.04	0.01
BTSHM	**-0.33**	-0.02	-0.21	-0.13	0.21	-0.03	-0.18	**-0.40**	0.06	0.02	**1.00**	**0.31**
BTSHmiss	-0.11	0.00	0.08	0.04	-0.01	-0.26	-0.18	**-0.41**	0.09	0.11	**0.33**	**1.00**

Legend: 7MTM – 7m throws - made; 7MTmiss - 7m throws - missed; 6MCSHM – 6m-centre shots - made; 6MCSHmiss – 6m-centre shots - missed; WSHM –wing shots – made; WSHmiss – wing shots – missed; FSHM – field shots - made; FSHmiss – field shots - missed; FBSHM – fast break shots – made; FBSHmiss – fast break shots – missed; BTSHM - breakthrough shots – made; BTSHmiss - breakthrough shots - missed

(6MCSHmiss). Moderate correlation (.39) was obtained between the variables 7m throws – missed (7MTmiss) and 6m-centre shots – made (6MCSHM).

Relations of the predictor variables of shooting for a goal with the criterion variable of the final outcome of handball matches

Table 5 presents information about the regression relations between the predictor variables of shooting for a goal and the criterion variable defined by the final outcomes of the matches (a victory or defeat) played at the European Championship in Rijeka and Zagreb in 2000.

significant (.99) influence on the playing performance of the observed sample:

- FSHM - field shots – made (0.53)
- 6MCSHM - 6m-centre shots - made (0.39)
- FSHmiss - field shots – missed (- 0.38)
- 7MTmiss – 7m throws – missed (- 0.31).

Besides the listed, the following two variables were significant at the .95 level:

- WSHM - wing shots - made (0.27)
- FBSHM - fast break shots – made (0.25).

It is important to stress here that the variables of unsuccessful shots for a goal have a negative sign, whereas the variables of successful shots have a positive sign.

Table 5. Regression analysis of relations between variables of successful/unsuccessful shooting at the goal and the final outcome of a match

	BETA	Std. Err. of BETA	B	Std. Err. of B	*t* (57)	p - level
Intercpt			-0.25	0.96	-0.26	0.79
7MTM	0.12	0.11	0.07	0.06	1.12	0.27
7MTmiss	**-0.31**	0.10	-0.24	0.08	-3.12	**0.00**
6MSHM	**0.39**	0.11	0.17	0.05	3.68	**0.00**
6MSHmiss	-0.03	0.10	-0.02	0.06	-0.31	0.76
SSHM	**0.27**	0.11	0.13	0.06	2.38	**0.02**
SSHmiss	-0.13	0.10	-0.08	0.06	-1.30	0.20
FSHM	**0.53**	0.13	0.16	0.04	4.50	**0.00**
FSHmiss	**-0.38**	0.11	-0.08	0.02	-3.39	**0.00**
FBSHM	**0.25**	0.11	0.11	0.05	2.28	**0.03**
FBSHmiss	-0.10	0.10	-0.07	0.07	-0.92	0.36
BTSHM	-0.03	0.11	-0.02	0.07	-0.27	0.79
BTSHmiss	-0.05	0.10	-0.06	0.12	-0.52	0.61

R = .71 R^2 = .50
F(12.57) = 4.81 p < .00002 Std. Error of estimate: .78

Legend: 7MTM – 7m throws - made; 7MTmiss - 7m throws - missed; 6MCSHM – 6m-centre shots - made; 6MCSHmiss – 6m-centre shots - missed; WSHM –wing shots – made; WSHmiss – wing shots – missed; FSHM – field shots - made; FSHmiss – field shots - missed; FBSHM – fast break shots – made; FBSHmiss – fast break shots – missed; BTSHM - breakthrough shots – made; BTSHmiss - breakthrough shots - missed

The coefficient of multiple correlation (.71) is statistically significant and leaves no doubt that success or victory in handball can be predicted from the variables of shooting for a goal.

Namely, they have explained 50% of the common variance of diverse ways of closing attack actions, both made and missed, and of the binary defined final match outcomes. As was determined in previous research (Rogulj, 2000; Srhoj et al., 2001), this research has also corroborated a variable contribution of the predictor variables to the definition of the criterion variable. On the basis of the partial regression coefficients and respective *t*-values of tests assessing their significance, it can be concluded that four predictor variables have a

The variable of scoring efficiency from the back-court player positions has the greatest positive projection on the final match result (.53), consequently, it differentiates the winning and the defeated teams very well. Obviously, if success is to be achieved in handball, a team should perform as many successful goal shots from a distance as possible in a game. To accomplish it, back-court players should avoid interruptions of the game flow, that is interfering, blocking, or preventing, performed by the players on defence, and they must throw the ball at the goal powerfully and accurately (Czerwinski, 1998, 2000; Rogulj, 2000; Srhoj et al., 2001).

The second large influence on the final match result has the variable 6m-centre shots – made (.39). The winning teams performed quite a number of actions which were, successfully, finished from the 6m-line. The accuracy of the 6m-centre shots is an important variable of the general scoring efficiency and eventual sport success. The scoring efficiency from the 6m line is particularly important when the opponent employs any kind of open defence (either the zone or the combined one). Such defence formations prevent back-court players from open shots, but simultaneously, open numerous chances for pivots (Czerwinski, 1998, 2000; Taborsky, 1996; Vuleta et al., 1996; Vuleta, 1997).

The variable field shots - missed is ranked third by its influence on the final match result (-.38). A negative sign is logical – successful teams should perform as few unsuccessful long distance shots at the goal as possible. The selection of shot plays a crucial role in this because an attacker should avoid any hindering action of a guard (blocked shot, interruption of the game flow, goalkeeper' save, etc.). A large number of missed back-court shots has a double negative effect – first is the missed scoring chance and the other is an open space for the opponents' fast break and easy scoring (Rogulj, 2000; Vuleta, 1997).

The fourth variable in descending order of influence size (-.31) is 7m throws - missed and it has a negative sign also. Unsuccessful 7m throws may compromise the desired sport achievement, therefore they should be minimized. Performers of penalty throws should be cunning and accurate shooters because they have to beat the opposing goalkeeper. If such a player is in a team, the concept of play should incorporate actions that may finish with a penalty throw. Good penalty throw efficiency has a positive effect on the whole team and may strongly motivate it (Srhoj et al., 2001; Vuleta, 1997).

The variable wing shots – made (.27) still has a strong predictive power. Being significant at the level of .95, this variable implies how important the realization from the wing positions may be. Each team should have high quality and aggressive wingers that are able to score even from the very sharp angles by employing various kinds of shots (e.g. a spinned shot, a lob or a floating ball). It is particularly important in contemporary handball because a lot of actions are realized from the wing positions as a consequence of the numerical advantage created.

The last variable with positive predictive power is fast break shots (.25). High fast break frequency implies the high efficiency of defensive actions, either of guards or of a goalkeeper. The new rule that allows the team which has just conceded a goal to take a throw-off, that is to cross the centre line before all the opposing players have returned to their half of the court, opens up a lot of opportunities for secondary fast-breaks and has enhanced the speed or rhythm of play.

Conclusion

The following can be concluded even at the level of structural analysis of scoring efficiency displayed at the 4th Men's European Handball Championship by top-level national teams:

1. The greatest average frequency per game was registered for the variables field shots – missed (12.60) and field shots – made (7.55). These numbers suggest that almost half of all the shots performed (44.61%) were executed from the back-court positions.
2. The winning teams were considerably more efficient in shots taken from the back-court positions and in the 7m throws than the defeated ones - (43.20%) and (76.53%) as compared to (32.52%) and (65.76%), respectively.
3. In other variables of shooting for a goal no such large numerical differences were obtained between the winners and the defeated teams.

Regression analysis gave useful information on relationships between the predictor variables of shooting at goal and the final results of handball matches of the observed sample. Multiple and partial regression coefficients revealed that the outcome of a handball match significantly depended on the realization of shots from various distances, that is from various playing positions. Multiple correlation of .71 is statistically significant and leaves no doubt that the predictor variables share 50% of common variance with the final results of the observed matches. The winning teams had more successful field shots (FSHM), 6m-centre shots (6MCSHM) and wing shots (WSHM), on the one hand, and fewer unsuccessful 6m-centre shots (6MCSHmiss), field shots (FSHmiss) and 7m throws (7MTmiss).

It is evident that the scoring efficiency from a distance and from the 6m line differentiates the successful teams (winners) from the unsuccessful (defeated) ones. Besides, the winning teams performed fewer unsuccessful 7m throws.

The obtained findings will contribute to a better understanding of the relationships that reign in the structure of the handball game and of the factors that either facilitate sport performance or interfere with it.

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POVEZANOST VARIJABLI ŠUTIRANJA NA GOL S KONAČNIM REZULTATOM RUKOMETNIH UTAKMICA EUROPSKOG PRVENSTVU 2000. GODINE ZA MUŠKARCE

Sažetak

Uvod

Svaka rukometna utakmica prigoda je za registriranje velike količine podataka o vrstama i kvaliteti djelovanja pojedinih igrača i sastava, koji su pogodni za interpretaciju. Istraživanja parametara situacijske efikasnosti u rukometnoj igri pružaju mogućnosti za predviđanje konačnog rezultata rukometne utakmice. U članku se znanstveno propituju pojedini elementi tehničko – taktičkog djelovanja u rukometu, čime se nastoji dati doprinos boljem razumijevanju njihove važnosti s obzirom na uspješnost ekipa. Naime, nisu svi situacijski pokazatelji uvijek jednako važni za konačan ishod utakmice ili, drugim riječima, različiti situacijski pokazatelji aktivnosti u fazi obrane i napada različito modeliraju konačan rezultata utakmice. Cilj je ovog istraživanja utvrditi povezanost tipičnih pokazatelja efikasnosti šutiranja na gol s konačnom rezultatom utakmice u vrhunskom rukometu.

Metode istraživanja

Podatke su prikupljali osposobljeni promatrači EHF-a na uzorku od 38 utakmica. Uzorak entiteta činilo je 12 reprezentacija koje su se plasirale u završnicu 4. europskog rukometnog prvenstva za rukometaše: Skupina A - Španjolska ESP, Njemačka GER, Francuska FRA, Hrvatska CRO, Norveška NOR i Ukrajina UKR; Skupina B - Rusija RUS, Švedska SWE, Portugal POR, Danska DEN, Slovenija SLO i Island ISL.

Uzorak manifestnih varijabli čini 12 varijabli standardnih pokazatelja situacijske efikasnosti šutiranja na gol koji se na utakmicama registriraju za svaku ekipu:

1.	Šutiranje na gol sa sedam metara – USPJEŠNO (**7MTM)**
2.	Šutiranje na gol sa sedam metara – NEUSPJEŠNO (**7MTmiss**)
3.	Šutiranje na gol sa šest metara – USPJEŠNO (**6MCSHM**)
4.	Šutiranje na gol sa šest metara – NEUSPJEŠNO (**6MCSHmiss**)
5.	Šutiranje na gol s krilne pozicije – USPJEŠNO (**WSHM**)
6.	Šutiranje na gol s krilne pozicije – NEUSPJEŠNO (**WSHmiss**)
7.	Šutiranje na gol s vanjskih pozicija – USPJEŠNO (**FSHM**)
8.	Šutiranje na gol s vanjskih pozicija – NEUSPJEŠNO (**FSHmiss**)
9.	Šutiranje na gol iz protunapada – USPJEŠNO (**FBSHM**)
10.	Šutiranje na gol iz protunapada – NEUSPJEŠNO (**FBSHmiss**)
11.	Šutiranje na gol iz prodora (prolaza) – USPJEŠNO **(BTSHM)**
12.	Šutiranje na gol iz prodora (prolaza) – NEUSPJEŠNO **(BTSHmiss)**

Kriterijska varijabla je binarno definirana na temelju konačnih rezultata rukometnih utakmica - **POBJEDNICI / PORAŽENI**

Za svaki podatak šutiranja na gol izračunati su osnovni deskriptivni parametri, a izračunati su i koeficijenti korelacije između prediktorskih varijabli. Prediktivna vrijednost varijabli šutiranja na gol u odnosu na kriterijsku varijablu utvrdila se algoritmom multiple regresije u statističkom paketu STATISTICA FOR WINDOWS, verzija 5.0.

Rezultati i rasprava

U tablici 1 nalaze se podaci o prosječnim uspješnim i neuspješnim šutiranjima na gol. koje su izvele i pobjedničke i poražene ekipe zajedno. Odnos između uspješnih i neuspješnih realizacija šutiranja s različitih pozicija pokazuje da je najveća efikasnost postignuta šutiranjem iz prodora (76.95%), šutiranjem sa 6 m (73.36%), šutiranjem iz protunapada (73%) i šutiranjem iz 7 m (71.3%), s puno manjom efikasnošću završavali su napadi šutiranjem s krilnih pozicija (51.85%) i posebno šutiranjem s vanjskih pozicija (37.1%). U posljednje dvije varijable postignuta efikasnost nije bila na očekivanoj razini (s distance oko 50%, a s krilnih pozicija oko 60%). U tablici 2 prikazani su osnovni deskriptivni parametri šutiranja na gol posebno za pobjedničke i posebno za poražene ekipe.

U tablici 3 prikazani su rezultati povezanosti varijabli šutiranja na gol. Od ukupno 66 koeficijenata korelacije, na razini 0.01 značajna su samo 4, odnosno 7%, i sva su četiri negativnog predznaka tek nešto iznad granice statističke značajnosti (-.30 do -.36). U modelu promatranih rukometnih igara veći broj uspješnih ili neuspješnih realizacija s vanjskih pozicija uvjetuje manji broj uspješnih realizacija s krilne pozicije, pozicije kružnog napadača ili prolazom prema golu. U taktičkom smislu ekipe su primjenjivale model igre u kojemu je prevladavala ili realizacija napada s distance ili s pozicije linijskih igrača (krilni i kružni napadači).

U tablici 4 prikazani su rezultati povezanosti varijabli šutiranja na gol pobjedničkih (ispod velike dijagonale) i poraženih (iznad velike dijagonale) ekipa.

Kod **pobjedničkih ekipa** je od ukupno 66 korelacijskih koeficijenata samo njih 11 statistički značajno (17%) na razini od 0.01; osam ih ima negativan predznak i kreću se u intervalu od -.33 do -.56, a tri imaju pozitivan predznak u intervalu od .33 do .48. Dobiveni korelacijski koeficijenti govore o specifičnim relacijama između varijabli šutiranja na gol iz daljine uspješno ili neuspješno s preostalim varijablama šutiranja koje nedvosmisleno ukazuju na činjenicu da ekipe rjeđe šutiraju s ostalih pozicija odluče li se na realizaciju s vanjskih pozicija (što može biti determirano snagom pobjedničke momčadi).

Kod **poraženih ekipa** samo njih 17 statistički je značajno (26%) na razini 0.01. - 11 ih ima negativan predznak (-.30 do -.50), a šest pozitivan predznak (.31 do .47). Poražene su ekipe svoje napadačke akcije uglavnom koncipirale i završavale s krilnih pozicija, jer su šutevi s vanjskih pozicija bili neuspješni, odnosno, ako su šutevi s vanjskih pozicija bili uspješni, manji broj lopti bio je upućen krilnim igračima te je neuspješnih šuteva s krilnih pozicija bilo manje.

U tablici 5 nalaze se informacije o regresijskoj povezanosti između prediktorskih varijabli šutiranja na gol i kriterijske varijable pobjeda – poraz. Koeficijent multiple korelacije (.71) je statistički značajan i nema nikakve sumnje da se uspjeh, odnosno pobjeda u rukometnim utakmicama može prognozirati na temelju varijabli šutiranja na gol. Time je objašnjeno 50% zajedničke varijance različitih načina uspješnih i neuspješnih realizacija napada u rukometu i binarno definiranog konačnog rezultata utakmice. I u ovom radu utvrđen je različit doprinos prediktorskih varijabli definiranju kriterijske varijable. Na temelju parcijalnog regresijskog koeficijenta i pripadajućih F-testova za procjenu njihove značajnosti može se zaključiti da četiri varijable značajno (99%) utječu na uspješnost u igri.

Najveću pozitivnu projekciju na konačan rezultat utakmice ima varijabla FSHM (.53) koja dobro razlikuje uspješne i neuspješne ekipe. Znači, za uspjeh u rukometnoj utakmici treba izvesti što veći broj uspješnih šutiranja s distance. Da bi u tom uspjeli, vanjski pucači moraju biti vrlo precizni i moraju imati vrlo jake udarce, a ne smiju obrambenim igračima dozvoliti prekid igre (ometanjem, blokiranjem i sprečavanjem).

Druga varijabla po veličini utjecaja na konačni rezultat utakmica je 6MCSHM (.39). Pobjedničke su ekipe izvodile dosta akcija koje su završavale na liniji vratareva prostora i to uspješno, a to pokazuje da je preciznost šuta sa šest metara ili tzv. “zicer” izuzetno važna varijabla o kojoj ovisi generalna efikasnost, odnosno uspjeh u igri. Efikasnost šutiranja sa šest metara važna je kad protivnik igra neku od dubokih formacija (zonsku ili kombiniranu) gdje se pokušava spriječiti vanjske pucače da budu efikasni sa svojih pozicija, jer time automatski otvara prostor za stvaranja izglednih situacija za šut s pozicije kružnog napadača.

Treća varijabla je FSHmiss (-.38). Puno neuspješnih udaraca prema golu s distance (blok, obrane vratara, vratnice) otvara protivničkim ekipama velike mogućnosti za izvođenje prve faze napada – protunapada, iz koje je najlakše postići pogodak.

Četvrta varijabla po veličini utjecaja na konačni rezultat utakmica je 7MTmiss i ima negativan predznak (-.31). Visok postotak realizacije šuta sa sedam metara izuzetno pozitivno i motivirajuće djeluje na cijelu ekipu.

Varijabla WSHM (.27) još uvijek ima značajnu prediktivnu moć na razini 95% (.05). Suvremeni rukomet zahtijeva u kompoziciji ekipe izuzetno kvalitetne, opasne i efikasne krilne igrače koji su sposobni uskočiti i s malih kutova te primjenom različitih načina šutiranja iz skoka (zavrtuljak, lob i dr.) postići pogodak. Izuzetno je važno da krilni igrači imaju visok postotak realizacije šuta, jer se puno akcija završava na krilnim pozicijama tzv. stvaranjem viška igrača.

Zadnja varijabla s pozitivnom predikcijskom moći jest FBSHM (.25). Realizacija protunapada podrazumijeva visoku efikasnost različitih obrambenih formacija ili vratarovih obrana. Novo pravilo da se može krenuti s centra iako se igrači protivničke ekipe još nisu vratili na svoju polovinu igrališta, omogućuje više protunapada i ubrzalo je rukometnu igru.

Zaključak

Najveću frekvenciju od svih varijabli ima FSHmiss (12.60), odnosno FSHM (7.55), tj. od ukupnog broja realizacija skoro polovica (44.61%) izvedena je šutiranjem s vanjskih pozicija. Pobjedničke ekipe su pokazale znatno višu efikasnost šutiranja s vanjskih pozicija (43.20%) od poraženih ekipa (32.52%) i šutiranja sa 7 m (76.53%) prema (65.76%).

Regresijska analiza pokazala je povezanost prediktorskih varijabli šutiranja na gol s konačnim rezultatima rukometne utakmice. Multipli i parcijalni regresijski koeficijenti pokazuju da konačni rezultat utakmice značajno ovisi o realizaciji šutiranja s različitih udaljenosti, odnosno s različitih igračkih mjesta. Multipla korelacija (.71) je statistički značajna i nema nikakve sumnje da prediktorske varijable dijele 50% zajedničke varijance s rezultatima rukometnih utakmica. Ekipe koje su pobjeđivale na utakmicama

europskog prvenstva u rukometu izvodile su više uspješnih šutiranja s devet metara (FSHM), 6 metara (6MCSHM) i krila (WSHM) te manje neuspješnih šutiranja sa 6 metara (6MCSHmiss), 9 metara (FSHmiss) i 7 metara (7MTmiss). Očigledno je da postotak šutiranja s distance i s linije 6 metara diskriminira uspješne od neuspješnih ekipa. Uz to ekipe koje pobjeđuju izvode manje neuspješnih šutiranja sa 7 metara.

Dobiveni rezultati doprinose boljem razumijevanju tehičko-taktičkog elementa šutiranja na gol kao čimbenika uspješnosti ekipa u rukometu. Generalizaciju rezultata, međutim, valja ograničiti na rukometne utakmice i rezultate praćenih ekipa, sudionika 4. europskog prvenstva za muškarce. Rad je dobra osnova za nastavak istraživanja uspješnosti rukometnih ekipa na drugim međunarodnim natjecanjima.