

PERFORMANCE INDICATORS OF TEAMS AT THE 2003 WORLD HANDBALL CHAMPIONSHIP FOR WOMEN IN CROATIA

Katarina Ohnjec, Dinko Vuleta, Dragan Milanović and Igor Gruić

University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia

Original scientific paper

UDC 796.322:796.092:167.2-055.2(497.5)“2003”

Abstract:

The research was conducted on a sample of 60 handball matches (a total of 120 play records of individual teams) during the preliminary part of the 2003 World Championship for women in Croatia. Twenty-four different female national handball teams were divided into four preliminary competition groups of six teams. The goal was to determine and analyse the factors of performance or situational efficiency in handball. The research focused on the differences in variances of the situational factors among the teams and on the contribution of standard situational parameters to the criterion outcomes of handball matches defined as the goal-difference in the match's final score. The sample of predictor variables encompassed the shooting efficiency parameters across playing positions, assists, 7-m-throws won, and technical errors committed. The criterion variable was defined as the goal-difference of the match's final score. Multivariate analyses of variance were used to determine the differences that were statistically significant at the level of $p < .01$ among the variances of the observed standard parameters of performance. Therefore, each preliminary group was observed separately. The series of regression analyses was used to define the contribution of the predictor variables to the performance of the teams. The obtained results showed that the performance of the teams in each group was described by different performance factors; the statistical significance was determined in all the groups at a high conclusion level ($p < .01$). The conclusion was that the final competition efficacy model or performance of the teams in every preliminary group or at the end of the competition was preconditioned by different factors.

Key words: *team handball, female senior players, national teams, World Championship, performance indicators, preliminary round, competition efficacy model*

Introduction

The game of team handball is defined by a very simple goal – one team strives to score more goals and to receive fewer goals than its opponent (Rogulj, 2003). Individual matches within the official competitions are the situations in which this ultimate, so simply defined, aim is realized. A handball match is a contest of two opponents, that is, two handball teams of variable handball proficiency, meaning their players' skills, motor abilities, physical fitness level and technical-tactical preparedness and knowledge are rarely even. The aspiration of both teams is the same: to beat the opponent or to achieve as favourable result as possible by applying all the by-the-rules-of-the-game allowed means, that is, by the application of handball technical-tactical elements being at the disposal of the players on the court. Insight into the repertoire of the technical-tactical elements applied in each match by both teams can be acquired by means of either the output of the game statistics software, which

collects data *in situ*, during the very match, or afterwards, by viewing a video footage of the match (Vuleta, Gruić, & Ohnjec, 2005). Such data, registered for each team separately (meaning there are always two sets of data for each match, pertaining to the two teams engaged in the match), represent the frequencies of the technical-tactical elements applied in the match observed. Analysis of the data, that follows their acquisition, allows a coach or any other handball expert to determine the game efficacy (performance) of the observed teams. Or, in other words, it is possible to determine the factors influencing the accomplished result and their contribution to it (Hughes & Bartlett, 2002).

The hierarchical structure of performance in sporting team games consists of 4 groups of inter-related factors (according to Milanović, 1997). The first factor group embraces the basic anthropological features. The second factor level describes performance by means of the specific handball features of the players, related to the specific physical fitness

features and to the level of technical-tactical proficiency. Contemporary handball is characterized by very intensive play activities which demand from players, female and male alike, the well-developed basic and sport-specific physical fitness, adjusted to the specific structures and demands of the game of handball. At the third level of the performance hierarchical model is the situation-related efficacy (performance realized by the application of technical-tactical elements) that determines directly the final outcome of a match (the fourth level of the model).

Handball experts and coaches, who analyse performance efficiency of their players *in situ* by monitoring certain, nowadays standardized, parameters of performance during the very competition, are able to reach an impartial judgement about every player's individual contributions to the team performance, as well as about the comprehensive performance of the team as a whole (team performance). They are simultaneously able to do the same for the opposing team, thus getting very important information about the appropriateness of their own tactical and strategic moves either in the actual match or in the one that is to follow. Unfortunately, a quick transfer of the official game statistics data to the teams and their leaders engaged in the actual match are available only at major competitions, that is, the European and World Championships.

Tendency and demands for ever higher top-level achievements, that is, victories, and only victories in sport in general, handball alike, have incited research and a series of experiments about the factors which influence performance and good sport achievements (Hughes & Bartlett, 2002; De Rose Jr., 2004; Vuleta & Milanović et al., 2004; Gómez et al., 2008). A review of previous research on performance efficacy in handball may be presented through three groups or three directions of investigations. The first group consists of the studies in which a descriptive approach was used to analyse the frequencies of various events in a game, that is, of the frequencies and successfulness of the application of numerous technical-tactical handball elements (Vuleta & Šimenc, 1989; Czerwinski, 1995, 1998, 2000). The establishment of the differences among handball teams grouped according to different criteria (victorious or defeated teams, better or worse ranked teams at an official competition, or any other criterion) is the basic aim of the studies in the second group (Rogulj, 2000, 2003; Gómez et al., 2008). The third group of studies is directed to the establishment of the influence various standard performance indicators have on differently defined performance criteria (Vuleta, Šimenc, & Delija, 1996; Vuleta, 1997; Srhoj, Rogulj, Padovan, & Katić 2001; Vuleta, Milanović, & Sertić 2003; Vuleta, Milanović, Gruić, & Ohnjec, 2005). The findings emerging from the mentioned direc-

tions of research on competition performance in handball are mostly based on the investigations of World and European Championships and the Olympic Games tournaments for men, whereas performance of female handball players was far rarely explored. Šafarykova and her colleagues (1978) observed 14 male and 7 female matches at the 1976 Olympic Games' handball tournaments. Their focus was on the closing attack actions. Fourteen performance factors were determined. Ignjatova (1982) investigated the motor activity of female handball players across playing positions at three quality levels of competition by observing the application of seven technical-tactical elements. The findings demonstrated the progressive tendency of the frequency of elements application being parallel to the progression of competition quality, except for the application of the element *dribbling the ball*. Taborsky (1996) analysed the game statistics indicators and tactical activity of the teams participating in the 10th Junior World Championship for Women held in Brazil in 1995. On the basis of 42 matches observed, he established, among other things, that the efficiency average in attack was about 60%. Viskić-Štalec, Brčić and Jaklinović-Fressl (1997) designed a system of performance measures consisting of 32 technical-tactical elements applied in the attack across playing positions in the game of handball. They found that the fewest technical errors in most variables were registered on average for the players in teams of the first quality group (the four best ranked teams at the end of the championship); these teams were also most efficient in all the variables related to *goal shooting*. Brčić, Viskić-Štalec and Jaklinović-Fressl (1997) verified the predictive power of the 43-item battery of technical-tactical variables aimed at assessing handball play. On the basis of the obtained results, they established that the battery successfully discriminated matches of the female teams pertaining to different quality categories, matches of the opponents pertaining to different quality categories, and matches played at home and away. Gruić, Vuleta, Milanović and Ohnjec (2005) tried to define the influence of situation-efficiency parameters of the backcourt players on the final outcomes of matches of the 2003 World Handball Championship for women held in Croatia. The obtained partial regression coefficients of the predictor variables demonstrated that the *successful goal shots of backcourt players*, performed from the positions of *pivots* and *wings*, had a statistically significant influence on the final success, defined as the goal-difference of the game score.

The main purpose of the present paper was to analyse the contribution of the performance (situation efficacy) indicators of play in attack to the final competition success, that is, to the final match outcome, defined by the final score goal-difference of matches played in particular competition groups

in order to find out if it would be possible to draw a unique model of play of successful teams.

Methods

The sample entities was comprised of a total of 120 game statistics records of the opponents engaged in 60 matches of the preliminary round of the 2003 World Handball Championship for women, held in Croatia. The participants were 24 national female handball teams, which were divided into four preliminary groups of six teams (in brackets are the final standings rank of the teams at the end of the Championships):

A	B
FRANCE (1)	RUSSIA (7)
SPAIN (5)	KOREA (3)
SERBIA & MONTENEGRO (9)	AUSTRIA (11)
CROATIA (14)	CZECH REPUBLIC (15)
BRAZIL (20)	ANGOLA (17)
AUSTRALIA (23)	URUGUAY (24)
C	D
UKRAINE (4)	HUNGARY (2)
NORWAY (6)	SLOVENIA (8)
ROMANIA (10)	GERMANY (12)
JAPAN (16)	DENMARK (13)
TUNIS (18)	CHINA (19)
ARGENTINA (22)	IVORY COAST (21)

The competition system was as follows: within a preliminary group 15 matches were played (each national team played with each other's national team – a simple round-robin system); that is, there were a total of 60 preliminary round matches. The three best-ranked teams from each preliminary group were qualified for the main competition, which was also conducted through the simple round-robin system within two groups of six teams.

A group of predictor variables was comprised of the frequencies of the goals scored and shots at the goal missed by the attackers from their playing positions: backcourt players, wings and (a) pivot(s), or from the goal area line and from fast breaks. Also, frequencies of assists, penalty throws won and technical faults made in attack were also registered. Table 1 displays the predictor variables which describe the situational efficacy of the players in attack.

At the 2003 World Handball Championships for Women held in Croatia, were used the software package WIGE DATA which is one of the availa-

ble means for game statistics data acquisition and competition monitoring. This sport software is a worldwide famous one due to its adjustability to the specificities of each sport, team and individual alike. The fact that every successive European or World competition has been covered by the mentioned system speaks in favour of its quality and popularity. For the present study the individual game Match Time Report files were selected from a large number of records and downloaded from the International Handball Federation official sites (www.ihf.com).

Table 1. The set of the predictor variables (1-10) and the criterion variable (12)

1	9M_S	Field shots scored – from the backcourt positions
2	9M_M	Field shots missed – from the backcourt positions
3	6M_S	Goal area line shots scored – from the pivot position
4	6M_M	Goal area line shots missed – from the pivot position
5	WI_S	Wing shots scored – from the wings' position
6	WI_M	Wing shots missed – from the wings' position
7	FB_S	Fast break shots scored – from a counter-attack
8	FB_M	Fast break shots missed – from a counter-attack
9	ASSIST	Assists
10	R7	Penalty throws won
11	TF	Technical errors in attack
12	GOAL DIFF	Goal difference

The **criterion variable** was defined as *the goal-difference* at the end of a match.

Data processing methods

Descriptive statistics with its fundamental measures of central tendency and dispersive parameters gave an overview of performance (situation efficacy) parameters. The differences in performance indicators among different competition groups were established by the multivariate analyses of variance. Simple regression analysis was used to investigate the contribution of individual performance parameters to the eventual game outcome. The collected data was processed by means of the statistical software package Statistica/w 5.0. and 6.0.

Results

In Table 2 the results of the descriptive statistical analysis are shown.

Table 2. Descriptive statistic of the performance parameters of the teams playing at the 2003 World Championship in Croatia

	N	TOTAL				VICTORY				DEFEAT			
		MEAN	%	SD	SUM	MEAN	%	SD	SUM	MEAN	%	SD	SUM
9M_S	120	7.73	34.10	3.30	928	8.29	41.95	3.44	481	7.19	28.35	3.13	417
9M_M	120	14.94		5.90	1793	11.47		4.28	665	18.17		5.54	1054
6M_S	120	4.23	70.03	2.35	508	5.05	80.40	2.42	293	3.45	66.22	2.04	200
6M_M	120	1.81		1.43	217	1.81		1.30	105	1.76		1.57	102
WI_S	120	4.97	50.07	3.07	596	6.09	57.85	3.40	353	3.78	36.45	2.28	219
WI_M	120	4.83		2.84	579	4.28		2.59	248	5.52		2.99	320
FB_S	120	4.94	76.94	4.23	593	7.26	80.66	4.77	421	2.83	68.68	1.97	164
FB_M	120	1.48		1.41	178	1.74		1.42	101	1.29		1.40	75
TOT_S	120	27.17	52.46	8.26	3260	32.86	61.31	6.23	1906	21.69	43.33	6.19	1258
TOT_M	120	24.62		6.89	2954	20.74		5.19	1203	28.36		6.50	1645
AS	120	15.26		9.36	1831	19.38		9.68	1124	11.12		7.37	645
R7	120	4.58		2.32	545	5.09		2.48	295	3.98		1.99	227
TF	120	17.73		6.61	2127	15.43		4.40	895	20.38		7.56	1182

N number of cases; **MEAN** arithmetic mean; **SD** standard deviation; **SUM** sum; **9M_S** field shots scored – backcourt positions; **9M_M** field shots taken, missed – backcourt positions. **6M_S** goal area line shots scored – pivot position; **6M_M** goal area line shots taken, missed – pivot position; **WI_S** side shots scored – wings' position; **WI_M** side shots taken, missed – wings' position; **FB_S** fast break goals scored – counter-attack; **FB_M** fast break goals taken, missed – counter-attack; **TOT_S** goals scored – total; **TOT_M** goals taken, missed – total; **AS** assists; **R7** penalty throws won; **TF** technical errors in attack

The total average number of shots and throws taken in the preliminary round was 51.79 with a shot efficacy of 52.46%. Regarding the playing positions, the largest number of shots was taken from the backcourt positions (perimeter, distance shots; 22.67 on average) with a shot efficacy of 34.10%, followed by the shots taken from the wings' positions (9.80 on average), with an efficacy of 50.07%, and shots taken from the goal area line (6.04 on average), with an efficacy of 70.03%. There was an average of 6.42 shots taken from fast breaks, out of which 76.94% were successful. The averages of assists and technical errors were 15.26 and 17.73, respectively. The teams won on average 4.58 penalty (7m) throws. In Table 2 the descriptive statistics of the performance parameters are presented of both the winning and the defeated teams in the preliminary round competition. The winning teams took on average 3.55 shots more than the defeated teams, with a considerable superiority in shot efficiency expressed in percentages 61.31% and 43.33%, respectively. From the backcourt positions the winning teams took 19.76 shots on average, with a shot efficacy of 41.95%, whereas the defeated teams directed 25.36 shots on average at the goal, out of which only 28.35% scored. The shot efficacy of the shots directed from the line positions (both the wings and the pivot positions) for the victorious teams was 64.65% out of the average total of 17.23 shots directed at the goal. The defeated teams, apart from taking fewer shots on average (14.51) from the same positions, were less efficient (only 49.82%) than the

winners. The winners were more frequently in the position to perform a fast break (8.69 counter-attacks on average), with the efficiency of 80.66% than the defeated teams who performed 4.12 fast breaks on average with an efficiency of 68.68%. The players in the winning teams cooperated more frequently (19.38 assists on average) than the players of the defeated teams (11.12 assists on average). Both groups of teams made a considerably larger number of technical errors (15.43 and 20.38 on average for the winners and the defeated, respectively), only the defeated team made five errors more per game on average. The winners won five penalty throws, whereas the defeated teams won only four.

The results of the multivariate analysis of variance, aimed at determining the differences between the groups with regard to the observed variables, are presented in Table 3.

Table 3. Multivariate analysis of variance

Intergroup differences	Wilks' Lambda	Rao's R	df 1	df 2	p-level
ABCD	.18	7.54	33	312	.00
AB	.50	4.44	11	48	.00
AC	.63	2.55	11	48	.01
AD	.10	38.10	11	48	.00
BC	.24	13.97	11	48	.00
BD	.24	13.97	11	48	.00
CD	.17	21.45	11	48	.00

df degrees of freedom; p-level level of significance

Further analyses of the influence of the parameters of situational efficacy in attack on sporting achievements of the observed teams are presented for each preliminary round group separately (Table 4).

In Table 5 the results of the regression analyses are displayed. The relations of the predictor group of variables with the criteria in all four groups are described with the coefficients of multiple correlations (Table 5).

The partial results of the regression analyses of the indicators of situational efficacy or performance indicators in particular competition groups in relation to the criterion *goal-difference* are presented in Table 6.

Table 5. Multivariate indicators of the contribution of the predictor variables to the successfulness criterion defined as the goal-difference(GOAL-DIFF) of the final match score

GOAL-DIFFERENCE	A	B	C	D
Multiple R	.93	.96	.96	.89
Multiple R ²	.86	.91	.92	.80
Adjusted R ²	.78	.86	.86	.67
F(11.18)	10.43	17.49	17.67	6.35
p	<.00	<.00	<.00	<.00
Std.err.	6.52	6.39	5.47	5.24

Multiple R multiple correlation, Multiple R² coefficient of determination, Adjusted R² adjusted coefficient of determination, F value of F-test, p level of significance of F-test, Std.err. standard error

Table 4. Descriptive statistic of performance across groups

	N	A			B			C			D		
		MEAN	%	SD	MEAN	%	SD	MEAN	%	SD	MEAN	%	SD
9M_S	30	9.40	36.53	3.8	6.17	31.16	2.63	7.63	32.52	3.2	7.73	35.62	2.79
9M_M	30	16.33		6.11	13.63		5.4	15.83		6.23	13.97		5.67
6M_S	30	3.90	66.10	2.11	3.43	65.20	2.08	4.00	73.66	2.12	5.60	73.97	2.58
6M_M	30	2.00		1.29	1.83		1.72	1.43		1.22	1.97		1.45
WI_S	30	4.57	50.77	2.74	4.77	51.45	3.33	4.00	48.19	2.38	6.53	51.82	3.28
WI_M	30	4.43		2.61	4.50		3.4	4.3		2.25	6.07		2.74
FB_S	30	4.87	78.04	3.53	5.90	77.32	3.93	5.87	77.22	5.95	3.13	73.99	2.22
FB_M	30	1.37		1.33	1.73		1.48	1.73		1.64	1.10		1.12
AS	30	9.07		4.93	14.67		10.14	12.77		7.15	24.53		6.78
R7	30	4.10		1.99	4.90		2.77	4.90		2.58	4.27		1.95
TF	30	18.93		7.12	19.07		8.32	18.13		5.59	14.77		3.96

N number of cases; MEAN arithmetic mean; SD standard deviation; 9M_S field shots scored – backcourt positions; 9M_M field shots taken, missed – backcourt positions. 6M_S goal area line shots scored – pivot position; 6M_M goal area line shots taken, missed – pivot position; WI_S side shots scored – wings' position; WI_M side shots taken, missed – wings' position; FB_S fast break goals scored – counter-attack; FB_M fast break goals taken, missed – counter-attack; AS assists; R7 penalty throws won; TF technical errors in attack

Table 6. Partial results of regression analysis of the performance indicators within the competition groups in relation to the criterion variable final goal-difference

	A		B		C		D	
	BETA	p-level	BETA	p	BETA	p-level	BETA	p
Intrcpt		.72		.59		.39		.72
9M_S	.00	.98	.07	.56	.07	.39	.06	.71
9M_M	-.23	.08	-.37	.00	-.12	.35	-.53	.09
6M_S	.07	.61	.07	.58	.00	.97	.43	.03
6M_M	.18	.13	-.13	.18	-.01	.91	-.43	.05
WI_S	.06	.71	.38	.01	-.02	.79	.32	.18
WI_M	-.06	.61	-.24	.02	-.18	.05	-.29	.04
FB_S	.29	.11	.13	.35	.53	.01	.14	.47
FB_M	.07	.56	.06	.60	.07	.47	-.04	.85
AS	.28	.13	.24	.27	.07	.71	-.18	.65
R7	-.15	.19	-.03	.85	.16	.13	.24	.15
TF	-.35	.05	-.16	.17	-.33	.00	.02	.89

BETA partial standard coefficient of regression; p-level value of significance threshold; Intrcpt intercept; 9M_S field shots scored – backcourt positions; 9M_M field shots taken, missed – backcourt positions. 6M_S goal area line shots scored – pivot position; 6M_M goal area line shots taken, missed – pivot position; WI_S side shots scored – wings' position; WI_M side shots taken, missed – wings' position; FB_S fast break goals scored – counter-attack; FB_M fast break goals taken, missed – counter-attack; AS assists; R7 penalty throws won; TF technical errors in attack

Discussion and conclusions

To obtain the relevant data on the situational efficiency of particular teams, that is, to obtain information containing reliable indicators of their competition performance, one must observe the confrontations of the same teams. The competition systems in which opponents meet twice, that is, the double round-robin system or the league system enables, according to the theory of measurement in kinesiology and previous research, more quality and comprehensive insight into performance in handball matches. The tournament-type competition system or elimination system, such as World Championships, meets only partially the minimum preconditions, defined as the matches in which each team should play against each other's team at least once, at the competition level of a preliminary round, during which each team in a group plays against every other team in the same group (the simple round-robin system). That is why each preliminary competition group was observed separately. Such an approach was justified by the results of the multivariate analysis of variance (Table 3), which denoted the differences among the groups both on a general level (all four groups) and on the level of individual groups. Out of the determined differences among the preliminary competition groups it is feasible to assume that each group was characterized by different factors of performance or success.

Based on the arithmetic means of variables registered for group A it can be said that the average total of shots taken was 52.97. From the backcourt positions the average of 25.73 shots were taken out of which 9.40 scored (36.53%), and 16.33 missed; from the line positions 14.90 shots were taken on average, out of which 8.47 scored (56.84%) and 6.43 missed; there were 6.24 shots taken from fast breaks on average, out of which 4.87 scored (78.04%) and 1.37 missed. This group is characterized by a high number of technical errors (18.93 on average).

Descriptive parameters of team performance in group B indicate that the teams in this group were poorly oriented towards scoring a goal, which was clearly manifested as the lowest number of shots taken (only 50.8 shots taken on average), and as the highest number of technical errors (19.07) in relation to the average of the entire preliminary round. The backcourt players in group B scored the fewest goals on average (6.17 per match), just one goal more on average than the wings of the same group. The backcourt shot efficiency was 31.16%, slightly less than in the other groups, whereas the wings' shot efficacy was 51.45%. Possible causes for fewer frequencies of the shots taken from the backcourt attacking positions were: 1) the tactically well-founded play of the guards, based on falling-outs to the backcourt attackers, 2) the physical condition status and technical-tactical skills of the opposing backcourt attackers were insufficient to

disturb the tactics of the defending formation. The authors assume that the same reasons produced a higher number of the registered technical faults (19.07 on average) and a smaller number of assists (14.67 on average).

When the descriptive statistics of the situational efficacy of the preliminary group C is compared to the results of the other groups, quite an average frequency of both the successful and unsuccessful shooting attempts became obvious (51.37 on average), out of which 23.46 shots on average were made from the backcourt positions, with a shot efficacy of 32.52%, and from the goal area line positions 13.73 shots, with an efficacy of 58.26%. The registered number of technical errors (18.13 on average) and assists (12.77 on average) is in accord with the results of the other groups.

In group D the far greatest number of shots was taken from the goal area line, in comparison to all the other groups, out of which from the wings' position the average of 12.60 shots with a shot efficiency of 51.82% and from the pivot player position an average of 7.57 shots with a shot efficiency of 73.97%. This group is characterized by twice as many of the number of assists (24.53 on average) and by the lowest number of technical errors (14.77 on average) among all the preliminary competition groups. We can presume that there was a special tactical accent on co-operation among team-mates, that is, on proper, timely passes, the fact being corroborated with the largest number of the registered assists in the total.

The simple regression analysis for the determination of the teams' performances with regard to the criterion the *goal-difference* resulted in the multiple correlation coefficient values (Table 5) ranging from .89 to .96. They were tested by means of F-distribution ($df_1=11$ and $df_2=18$), and showed a statistically significance at the level of $p<.01$. The common variability of the predictor system is different across the groups, ranging in the interval from 80 to 92% (multiple $R^2 = <.80, .92>$), that is, in the interval from 67 to 86 % (adjusted $R^2 = <.67, .86>$). The authors suppose that the entire explanation, that is, the explanation of the rest of 14-33% of the variability defined by the *goal-difference* variability can be obtained from the variables not included in the present predictor variables, such as: the number of the set, position attacks, duration of attacks, situation-related efficiency of the opposing team, performance on defence (of the goalkeeper and of players on defence) and others. In several analyses of performance indicators, for example, of the World Championship for men held in Portugal in 2003 (Gruić, 2006), conducted with the aim of determining the contribution of the group of situation-related predictor variables to the explanation of performance criterion, the similar values of the determination coefficient were obtained (multiple

$R^2 = .82-.89$). In the investigation of the backcourt female players' performance at the 2003 World Championship (Gruić, Vuleta, Milanović, & Ohnjec, 2005) a somewhat lower value of the multiple correlation coefficient was obtained (multiple $R^2 = .67$). It can be explained by the influence of the play of the wings and pivots, as well as by other performance factors emerging from the quality of play of the own team and of the opponent.

Only those partial regression coefficients across individual groups were included in the analysis which met the criterion of the statistical significance level of $p < .05$. The results of the partial regression analysis do not allot a statistical significance to any predictor variable in the competition group A (Table 6), meaning that none of the observed play segments contributed to the final outcome to the extent of a statistical significance. The performance of the teams pertaining to this group can be explained by harmonized, balanced technical-tactical activities, the actions of players from all play positions.

In group B the variable *wing shots scored* (WI_S) had a statistically significant contribution ($BETA = .38$) to the final result successfulness defined as the *goal-difference* of the match score, whereas the variable *wing shots missed* (WI_M) had a statistically significant negative influence ($BETA = -.24$) on the final score *goal-difference* of the matches in the preliminary group B. At a very high conclusion level the same is valid for the variable *field shots missed* (9M_M) ($BETA = -.37$). The generators of success in this group were the play of the wings and the backcourt players. It can be concluded from the statistical significance that the limitation, that is, the reduction of the unsuccessful shots attempted from the backcourt play positions defined the result achievements in the competition group B. Namely, unsuccessful attack conclusions from the backcourt positions are usually a consequence of poorly set and realized attack actions. Further, the role of the wings in the performance definition in group B also included the reduction of missed shots, and the enlargement of the number of the shots scored. Essential in the proper selection of wing shots were the following: well adopted and properly developed technical-tactical skills and knowledge, the level of physical fitness, as well as the cognitive abilities and personality traits.

In group C the variable *fast break goals scored* (FB_U) had a statistically significant positive influence ($BETA = .53$), whereas the variable *technical faults* (TF) had a statistically significant negative influence ($BETA = -0.33$) on the description of the criteria of the *goal-difference*. For the play of the successful teams pertaining to this competition group it can be presumed that they reacted timely and efficiently to the opponents' technical faults and used them to score "easy goals", that is, their performance was characterised by the successful

realization from fast breaks. The ability to perform a quality and successful fast break is determined on the one hand by the fast, well-timed and accurate reaction of the players or a goalkeeper, who forward the ball into the fast break, and on the other hand, by the reaction speed and running speed of a player(s) who opens herself into the free space in front of the opponent's goal, thus getting or creating a 100% scoring chance.

The variable *line shots scored* (6M_S) had a statistically significant positive influence ($BETA = .43$) on the criterion, whereas the variable *line shots missed* (6M_M) had a statistically significant negative influence ($BETA = -.43$) on the success (defined as the *goal-difference*) of the teams in group D. At a very high level of conclusion the same may be stated for the variable *wing shots missed* (WI_M) ($BETA = -.37$). The shots taken from the line positions (wings and a pivot) and their efficiency determined the sport success of the teams in group D. The probable reason for that was an application of deeper defensive zone formations, focused on denying the backcourt players' chances for scoring or even shooting at the goal. Therefore, the backcourt players changed their primary role of scorers into the role of passing the ball to the line players. Such an open play enabled a lot of scoring chances from the goal area line. For the good performance of the teams in group D a reduction of unsuccessful shots taken from the wings' positions was necessary. Tactical discipline, which implies rational play in attack and waiting for an open scoring chance from the wings' positions, was a pronounced characteristic of the successful teams in group D.

By a series of regression analyses the contribution of the predictor variables to the performance of the observed teams was analysed. In each group performance was described by different predictor variables, but in each and every at a very high level of significance ($p < .05$). It should be accentuated here that the obtained significant results regard the situational efficacy of particular national teams competing in the preliminary round of the World Championship during the period of December 2-14, 2003. The magnitude and structure of the sample of entities and of the set of the observed variables limited the value of the obtained results so that they should be treated with caution because of any possible interpretation mistakes. However, certain general conclusions can be drawn – the determined performance factors implied the simultaneous, harmonious offensive (scoring - aimed) activity of all players in attack. The findings about the performance of the observed teams indicated the importance of rational, economy-based shots taken both from the backcourt and from the line (a pivot and the wings) play positions. Potential space for the future development of female team handball can be found in the following: improvement of the

individual actions of the backcourt players without the ball, tactical improvements and elaborations of various actions of group and team attack with a special accent on the improvement of players' perception of play, out of which good passes (assists) result to the players in the best positions for scoring or 7-m throws winning.

A considerable variability of the observed parameters and awareness that only fragments of the complexity of the game of handball were covered in this investigation, indicate the necessity to modify

the actual way of recording and assessing performance by the selected parameters. Such a modified form should be established as an official record of and report from any match of national competitions. In this way a comparison of performance in particular national handball competitions will be viable.

The most important conclusion is that performance and success in contact team sports depend on many various factors, and that situation efficacy models are different with each team and almost each match (Gruić, 2006).

References

- Brčić, B., Viskić-Štalec, N., & Jaklinović Fressl, Ž. (1997). The predictive value of variables for the evaluation of technical-tactical elements in handball. *Kinesiology*, 29(1), 55-64.
- Czerwinski, J. (1995). The influence of technical abilities of players on the tactical selection in the handball game. *EHF Periodical*, 2 (1995), 16-19.
- Czerwinski, J. (1998). Statistical analysis of the men's European Championship held in Italy 1998. *EHF Periodical*, 2 (1998), 10-18.
- Czerwinski, J. (2000). Statistical analysis and remarks on the game character based on the European Championship in Croatia. *EHF Periodical*, 2 (2000), 10-18.
- De Rose Jr., D. (2004). Statistical analysis of basketball performance indicators according to home/away games and winning and losing teams. *Journal of Human Movement Studies*, 39 (2), 85-104.
- Gómez, M.Ai., Lorenzo, A., Barakat, R., Ortega, E., & Palao, J.M. (2008). Differences in game-related statistics of basketball performance by game location for men's winning and losing teams. *Perceptual and Motor Skills*, 106, (1), 43-50.
- Gruić, I. Vuleta, D., Milanović, D., & Ohnjec, K. (2005). Influence of performance parameters of backcourt attackers on the final outcomes of matches of the 2003 World Handball Championship for Women in Croatia. In D. Milanović & F. Prot (Eds.), *Proceedings Book of the 4th International Scientific Conference on Kinesiology "Science and Profession – Challenge for the Future"*, Opatija, Croatia, 7-11 September, 2005 (pp. 474-477). Zagreb: Faculty of Kinesiology, University of Zagreb.
- Gruić, I. (2006). *Situacijska efikasnost muških rukometnih ekipa na svjetskom prvenstvu u Portugalu 2003. [Situation efficacy of male handball teams at the 2003 World Championships in Portugal. In Croatian.]* (Master's thesis, University of Zagreb). Zagreb: Kineziološki fakultet.
- Gruić, I., Vuleta, D., & Ohnjec, K. (2006). Utjecaj postignutih golova tijekom rukometnih utakmica svjetskog prvenstva za žene u Hrvatskoj 2003. na konačni rezultat. [Influence of the goals scored on the final outcomes of matches of the 2003 World Handball Championships for Women in Croatia. In Croatian.] In V. Findak (Ed.), *Proceedings, 15th Summer School of the Kinesiologists of the Republic of Croatia*, Rovinj (pp. 126-133). Zagreb: Hrvatski kineziološki savez.
- Hughes, M.D., & Bartlett, R.M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, 20(10), 739-754.
- Ignjatova, V. J. (1984). Motorna aktivnost rukometašica na takmičenjima (prijevod iz Teorija i praktila fizičeskoj kulturi, 9/82, Moskva). [Motor activity of female handball players at certain competitions. The translation from the Teorya y praktika fiziceskoy kultury, 9/82, Moscow.] In S. Savić (Ed.), *Rukomet 8* (pp. 50-52). Beograd: Zavod za fizičku kulturu.
- Milanović, D. (1997). Osnove teorije treninga. [Fundamentals of the theory of training. In Croatian.] In D. Milanović (Ed.), *Priručnik za sportske trenere* (pp. 483-603). Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu.
- Rogulj, N. (2000). Differences in situation-related indicators of the handball game in relation to the achieved competitive results of teams at 1999 World Championship in Egypt. *Kinesiology*, 32(2), 63-74.
- Rogulj, N. (2003). Učinkovitost taktičkih modela u rukometu. [Effectiveness of tactical models in handball. In Croatian.] (Doctoral dissertation, University of Zagreb). Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu.
- Srhoj, V., Rogulj, N., Padovan, M., & Katić, R. (2001). Influence of the attack and conduction on a match result in handball. *Collegium Antropologicum*, 25(2), 611-617.
- Šafarykova, J. (1978). Primjena spoznaja o šutu u rukometu (prijevod Trener, 4/77, Bratislava). [Effectiveness of tactical models in handball. The translation from Trener, 4/77, Bratislava.] In *Rukomet 2* (pp. 32-35). Beograd: Zavod za fizičku kulturu.

- Taborsky, F. (1996). The 1995 Women's Junior World Championship. *EHF Periodical*, 2 (1996), 7-11.
- Viskić-Štalec, N., Brčić, B., & Jaklinović Fressl, Ž. (1997). Analiza pogrešaka u rukometnoj igri. [Analysis of technical-tactical errors in the game of handball. In Croatian.] In *Proceedings of the 21st Seminar for Handball Coaches*, Pula, 3-8 January, 1997 (pp. 21-31). Zagreb: Hrvatski rukometni savez.
- Vuleta, D., & Šimenc, Z. (1989). Analiza nekaterih kazalcev učinkovitosti igre mladinske rokometne reprezentance na VII. svetovnom prvenstvu. [Analysis of certain performance indicators of the youth handball national team at the 7th World Championship. In Slovenian.] *Trener, Rokomet* 1, 25(3/582), 3-42.
- Vuleta, D., Šimenc, Z., & Delija, K. (1996). Analiza nekih situacijskih pokazatelja rukometaša u fazi napada. [Analysis of certain performance indicators of performance in attack. In Croatian.] In D. Milanović (Ed.), *Proceedings, International Symposium "Diagnostics of Athletic Fitness and Preparedness"*, Zagreb (pp. 180-183). Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu.
- Vuleta, D. (1997). Povezanost nekih bazičnih i situacijsko-motoričkih sposobnosti rukometaša kadeta. [Relations of certain basic and situational motor abilities of cadet handball players. In Croatian.] In D. Milanović (Ed.), *Proceedings of the 1st International Scientific Conference "Kinesiology – the Present and the Future"*, Dubrovnik (pp. 168-170). Zagreb. Fakultet za fizičku kulturu Sveučilišta u Zagrebu.
- Vuleta, D., Milanović, D., & Sertić, H. (2003). Povezanost varijabli šutiranja na gol s konačanim rezultatom rukometnih utakmica Europskog prvenstva 2000. godine za muškarce. [Relation among variables of shooting for a goal and the outcome of the 2000 men's European Handball Championship matches. In Croatian.] *Kinesiology*, 35(2), 168-183.
- Vuleta D., Milanović, D., et al. (2004). Znanstvena istraživanja u rukometu. [Scientific research in handball. In Croatian.] Zagreb: Kineziološki fakultet, Hrvatski rukometni savez.
- Vuleta, D., Milanović, D., Gruić, I., & Ohnjec, K. (2005). Influence of the goals scored on final outcomes of matches of the 2003 World Handball Championships for Men in Portugal. In D. Milanović & F. Prot (Eds.), *Proceedings Book of the 4th International Scientific Conference on Kinesiology "Science and Profession – Challenge for the Future"*, Opatija, Croatia, 7-11 September, 2005 (pp. 470-473). Zagreb: Faculty of Kinesiology, University of Zagreb.
- Vuleta, D., Gruić, I., & Ohnjec, K. (2005). Informatizacija u rukometu. [Information and computer science advances in handball. In Croatian.] In V. Findak (Ed.), *Proceedings, 15th Summer School of the Kinesiologists of the Republic of Croatia*, Rovinj (pp. 256-261). Zagreb: Hrvatski kineziološki savez.

Submitted: September 4, 2007

Accepted: April 29, 2008

Correspondence to:
Katarina Ohnjec, MSc
Faculty of Kinesiology, University of Zagreb
Horvaćanski zavoj 15
10000 Zagreb, Croatia
Phone: + 385 1 365 87 54
Fax: + 385 1 36 34 146
E-mail: kohnjec@kif.hr

POKAZATELJI SITUACIJSKE UČINKOVITOSTI EKIPA SUDIONICA SVJETSKOG PRVENSTVA ZA RUKOMETAŠICE, ODRŽANOG 2003. GODINE U HRVATSKOJ

Sažetak

Uvod

Rukometnu igru obilježava jednostavno definirani cilj - postizanje što većeg, odnosno primanje što manjeg broja pogodaka (Rogulj, 2003). Pojedine utakmice službenih natjecanja situacije su kada se tako jednostavno definirani cilj želi konkretizirati. Svako se nadmetanje prati službenim statističkim programom u samom tijeku natjecanja ili se pak naknadno pregledava video zapis utakmice. Analizom prikupljenih podataka moguće je utvrditi efikasnost promatranih ekipa, odnosno čimbenike koji su pridonijeli ostvarivanju postignutog rezultata. Stručnjaci i treneri koji analiziraju efikasnost svojih igračica u natjecateljskim uvjetima u mogućnosti su donijeti racionalnu odluku o pojedinačnom učinku svake igračice i ekipe u cjelini te ujedno analizom igre protivničke ekipe izvršiti kvalitetnu pripremu za sljedeću utakmicu. Nažalost, brzi transfer službenih statističkih obrada pojedinih utakmica rukometni eksperti mogu koristiti samo na natjecanjima europske i svjetske razine.

Za potrebe ovog istraživanja korišteni su podaci prikupljeni na Svjetskom prvenstvu u rukometu za žene, održanom u Hrvatskoj 2003. godine. Cilj rada je analizirati doprinos pokazatelja situacijske efikasnosti u napadu na natjecateljsku uspješnost, tj. na konačni ishod utakmice definiran gol-razlikom na kraju utakmice u pojedinim natjecateljskim skupinama.

Metode istraživanja

Uzorak entiteta predstavlja 120 zapisa podataka o igri 24 nacionalne ekipe u 60 utakmica preliminarnog dijela Svjetskog rukometnog prvenstva za žene 2003. godine u Hrvatskoj. Sudionice prvenstva bile su podijeljene u četiri skupine po šest ekipa. *Prediktorski skup* varijabli sadrži frekvencije uspješnog i neuspješnog šutiranja napadača s različitih igračkih pozicija (vanjskih, linijskih i krilnih) i iz protunapada te frekvencije asistencija, izbornih sedmeraca i tehničkih pogrešaka. Za potrebe ovog istraživanja pri utvrđivanju uspješnosti korištena je kriterijska varijabla *gol-razlika* na kraju utakmice.

Rezultati

U preliminarnom dijelu natjecanja ukupni prosjek broja udaraca upućenih prema голу iznosi 51,79 s postotkom uspješne realizacije od 52,46%. S obzirom na igračke pozicije, najviše udaraca upućeno je s vanjskih pozicija (prosječno 22,67) s postotkom uspješne realizacije od 34,10%. Slijede udarci s krilnih pozicija (prosječno 9,80), s postotkom uspješne realizacije od 50,07%, zatim udarci s mjesta kružnog napadača (prosječno 6,04) s

postotkom uspješne realizacije od 70,03%. Iz protunapada su prosječno upućena 6,42 udarca, od čega je uspješno realizirano oko 76,94%. Prosječan broj asistencija iznosi 15,26, a tehničkih pogrešaka 17,73. Ekipe su u prosjeku iznudile 4,58 sedmeraca na utakmicama. Pobjedničke ekipe prosječno su upućivale 3,55 udaraca na vrata više od poraženih ekipa, s razlikom u uspješnosti realizacije izražene u postocima u odnosu 61,31% : 43,33% u korist pobjedničkih ekipa. S vanjskih pozicija pobjedničke ekipe prosječno su upućivale ukupno 19,76 udaraca, sa 41,95% uspješne realizacije, a poražene ekipe 25,36 udaraca od kojih je 28,35% uspješno realizirano. Uspješnost realizacije s linijskih pozicija (krilo i kružni napadač) za pobjedničke ekipe iznosila je 66,16% od ukupno upućenih prosječno 17,23 udarca. Porazene ekipe, osim što su upućivale prosječno manje udaraca (14,51) s istih pozicija, imale su i slabiju realizaciju – 49,82%. Pobjedničke ekipe češće su dolazile u situacije za protunapadačko djelovanje (prosječno 8,69 puta) s uspješnijom realizacijom (80,66%) u odnosu na poražene ekipe, koje su od prosječno 4,12 protunapada uspješno realizirale 68,68%. Igračice pobjedničkih ekipa učestalije su surađivale (prosječno 19,38 asistencija) od igračica poraženih ekipa (prosječno 11,12 asistencija). Prosječno veliki broj pogrešaka imale su obje ekipe (15,43 pobjedničke, 20,38 poražene) s time da su u prosjeku po utakmici poražene ekipe imale pet pogrešaka više. Situaciju za realizaciju kaznenog udarca pobjedničke ekipe ostvarile su prosječno pet puta na utakmici, a samo jednom manje istu situaciju iznudile su poražene ekipe.

Rezultati parcijalne regresijske analize ne pridaju statističku značajnost nijednoj varijabli prediktorskog skupa u natjecateljskoj skupini A, odnosno nijedan promatrani segment nije doprinio rezultatu u toj mjeri da bi se mogla determinirati statistička značajnost. Varijabla *uspješan šut s krilnih pozicija* (WI_U) u skupini B ima statistički značajan pozitivan utjecaj (BETA=.38) na konačnu rezultatsku uspješnost definiranu *gol-razlikom* na kraju utakmica. Na isti kriterij u skupini B statistički značajan, ali negativan utjecaj (BETA=-.24; -.37) imaju varijable *neuspješan šut s krilnih pozicija* (WI_N) i *neuspješan šut s vanjskih pozicija* (9M_N). U natjecateljskoj skupini C varijabla *uspješan udarac iz protunapada* (FB_U) ima statistički značajan pozitivan utjecaj (BETA=.53), dok varijabla *tehničke pogreške* (TF) ima statistički značajan negativan utjecaj (BETA=-.33) u objašnjenju kriterija *gol-razlika*. U skupini D, varijabla *uspješan šut s pozicije kružnog napadača* (6M_U) ima statistički značajan pozitivan utjecaj (BETA=.43) na definirani kriterij uspješnosti, dok varijable *neuspješan šut s pozicije kružnog napadača* (6M_N) te *neuspješan šut krilnih napadača* (WI_N) imaju statistički značajan

negativan utjecaj (BETA=-.43;-.37) na uspješnost ekipa, definiranu *gol-razlikom*.

Rasprava i zaključak

Doprinos prediktorskih varijabli u definiranju uspješnosti ekipa u pojedinim preliminarnim skupinama analiziran je serijom regresijskih analiza. U svakoj skupini uspješnost je opisana različitim varijablama prediktorskog skupa, no kod svih je utvrđena visoka značajnost na razini zaključivanja ($p < .01$). Zajednički varijabilitet prediktorskog skupa i kriterija (*gol-razlika*) opisan je vrijednostima koeficijenta determinacije, koji se kreće u rasponu od .67 do .86 obzirom na različite najecateljske skupine. Pretpostavlja se da potpuno objašnjenje, odnosno 14 do 33% varijabiliteta kriterija definiranog *gol-razlikom* leži u varijablama koje nisu obuhvaćene ovim skupom prediktorskih varijabli, kao što su: broj postavljenih napada, dužina napada, situacijska efi-

kasnost protivničke ekipe, situacijska efikasnost u obrani (vratara, obrambenih igrača) i sl. Bitno je naglasiti kako veličina i struktura uzorka entiteta i promatranih varijabla ograničava vrijednost dobivenih informacija te upozorava na mogućnosti pogrešaka u interpretaciji. Opći zaključci koji se odnose na utvrđivanje čimbenika situacijske efikasnosti podrazumijevaju istovremeno skladno ofenzivno djelovanje svih napadačkih linija. Rezultati provedenih analiza na ovom prvenstvu ističu važnost racionalizacije štitiranja vanjskih te linijskih (krilnih i kružnih) napadačica u definiranju uspješnosti pojedinih ekipa. Rezultatska uspješnost ovisi o različitim čimbenicima, dok se model situacijske efikasnosti razlikuje od ekipe do ekipe u svakoj pojedinoj utakmici (Gruić, 2006). Dobiveni rezultati o uspostavljenim relacijama pokazatelja situacijske efikasnosti u fazi napada značajno doprinose razvoju modela igre za buduća velika natjecanja.