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Analysis of Indicators of Load During the Game in Activity of the Second Line Attacker in Water Polo

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A B S T R A C T

Water polo, as an activity, belongs in the category of polystructural complex move sports. The activities of a player's in role of second line attacker is observed on the sample of competitive games in the First national league. The study is aimed to define a set of new measurement variables for the objective recording of amount, intensity and duration of player's activities, and its evaluation by means of factor validity criteria. On the sample of 87 players, 29 variables were applied. Competent, trained officials made measurements. Basic statistics of all measured variables is presented as referent values of various player activities. In the factor analysis, three factors are found to be significant, explaining 84.6% of source variability, which is a subset of multivariate normally, distributed variables. Factors are interpreted as: »quantity of actions«, »intensity of activity in the vertical body posture«, and »intensity and extensity of activity in horizontal body posture«. Of the last two, body posture is found to be specific in water polo, due to specifics of the game that is played in water. It is concluded that the proposed variables and measurement procedures are very well suited and objectively instrument for the purpose of measurement of the energetic aspect of kinesiological activity analysis.

Key words: *water polo, attacker, indicators of load*

Introduction

Sports activities and the water polo team game likewise can be analyzed in respect of two basic kinesiological perspectives: the first is energetic, dealing with amount, intensity and duration of motor actions; the second is dealing with information flow where technique, tactical, and strategic aspects are treated. It is obvious that, tacitly assumed, energetic abilities are of utmost importance for the

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players in order to be capable to fulfill their roles and duties in team tactics. Characteristic course of the water polo game, the positioned attack is organized of player's actions, defined by their roles, to enable the team to attempt to score. The positioned attack phase in water polo is a situation when one player positions himself at about two meters in front of the goal (center role), two players are positioned on the sides (wing role), and remaining players are in second line attackers role[1–6]. In the defense game phase, players are covering opposing team players according to their attack roles. The second line attackers role is dominated by a large amount of swimming and therefore with critical loads in the horizontal posture, and, duels as activity in the vertical posture are less dominant[5–6].

In this experimental study, we are dealing with amount and variety of energetic loads of the player in role of second line attacker in water polo. In order to accomplish this aim, it was necessary to define a new sample of variables for the objective measurement of all second line attackers activities during a competition game. It is expected that from a wider selection of variables, it would be possible to find such subset of variables, satisfying conditions for multivariate statistical analysis, to establish a latent source of variability of second line attackers actions.

Studies oriented to the observation of players loads during competition in team games and analysis in respect to amounts, types and intensities of player's actions in game are not very common. Studies of team game analysis in regard to the players or team efficiency in competition games, or aimed for analysis of game structure, are more present, and beside water polo, also cover other team games as soccer[6,7], basketball[9–11], or volleyball[12].

Materials and Methods

Experiment description

Activity of a second line attacker during a game was monitored and recorded during official competition games of the First national water polo league. The officials were positioned high where they had optimal view of the playing field and of the official time clock that showed the official clean game time and time clocks that showed attack time. Standard water polo playing field markers (2 and 4 meter signs, etc.) are used as very good reference for estimation of swimming distances. All games selected for the experiment were played in same swimming pool. Each of six officials consecutively recorded every action taken by his designated player. In order to qualify, each official had to undergo special training and pass the appropriate test of consistency in measuring.

Sample

Entities, or basic information source, in this analysis, are quarters of the water polo game. According to rules, water polo is played in quarters of 9 minutes of duration in clean game time (about 20 minutes of real time). Between the quarters are pauses (2–4 min). Measured samples used in this analysis consist of 87 quarters of the officially played competition games.

Variables

Actions of players in water polo, as set of game elements are recorded[4]. Variables were defined to measure: frequencies of actions, the distances passed on the playing field recorded in meters, and, estimate of intensity of appropriate action in modalities of: low, sub maximal and maximal. The number and duration of duels are measured in seconds, which a player spends in the game with uneven number of players (»players more« or »pla-

TABLE 1
VARIABLES AND THEIR DESCRIPTIONS

No.	Variables' names	Description
1.	FKRMAX	Frequency of swimming style crawl, intensity – maximal
2.	FLEDMAX	Frequency of swimming style backstroke, intensity – maximal
3.	FKRSMX	Frequency of swimming style crawl, intensity -sub maximal
4.	FLEDSMX	Frequency of swimming style backstroke, intensity –sub maximal
5.	FKRLAG	Frequency of swimming style crawl, intensity –low
6.	FLELAG	Frequency of swimming style backstroke, intensity –low
7.	FPRLAG	Frequency of swimming style breaststroke, intensity –low
8.	FDUEL	Frequency of duels
9.	FIGVIS	Frequency of actions with player more
10.	FIGMAN	Frequency of actions with player less
11.	MKRMX	Distance in crawl in maximal speed in meters
12.	MLEDMX	Distance in backstroke in maximal speed in meters
13.	MKRSMX	Distance in crawl in sub maximal speed in meters
14.	MLEDSMX	Distance in backstroke in sub maximal speed in m
15.	MKRLAG	Distance in crawl at low speed in meters
16.	MLEDLAG	Distance in backstroke at low speed in meters
17.	MPRLAG	Distance in breaststroke at low speed in meters
18.	SDUEL	Time duration of duels in seconds
19.	SIGVIS	Time duration with players more in seconds
20.	SIGMAN	Time duration with players less in seconds
21.	SUKUPNO	Total time spent in play in seconds
22.	FMXSMX	= FKRMX+FLEDMX+FKRSMX+ FLEDSMX
23.	MMXSMX	= MKRMX+MLEDMX+MKRSMX+ MLEDSMX
24.	FLAGAN	= FKRLAG+FLEDLAG+FPRLAG
25.	MLAGAN	= MKRLAG+MLEDLAG+MPRLAG
26.	FIGVM	= FIGVIS+FIGMAN
27.	SIGVM	= SIGVIS+SIGMAN
28.	FAKCIJA	= FMXSMX+FLAGAN+FIGVM
29.	METARA	= MMXSMX+MLAGAN

yer less«). In whole, a sample of 21 variables is used for recording of player activity in the game (Table 1). Beside those, another eight variables were calculated as unpondered linear sum as it is shown in the equations in Table 1. Those variables are: FMXSMX as a measure of total frequency in crawl and backstroke swimming with maximal and sub-maximal intensity, MMXSMX as a measure of total distance in meters in crawl and backstroke swimming with maximal and sub -maximal intensity, FLAGAN as a measure of total frequency in crawl and backstroke swimming with low intensity, MLAGAN as a measure of total distance in crawl and backstroke swimming with low intensity, FIGVM, SIGVM are respectively frequency and time duration in totals of play with uneven number of play-

ers for teams due to exclusions by game referee, FAKCIJA as total frequencies of actions, and METARA as total distances passed by player in meters.

Data analysis

The basic statistics have been calculated, moments of distributions, i.e., arithmetic mean, standard deviation, kurtosis and skew ness of distributions, and minimal and maximal result, for each analyzed variable. The matrix of Pearson correlation coefficients between variables is calculated and factor analysis, under component model, was performed. The final factor solution was defined according to OBLIMIN oblique factor rotation criterion. The analysis was performed using standard SPSS package for Windows (version 10.0).

Results and Discussion

As shown in Table 2, the number of variables, because of their scattered occurrences during the game, does not have normal distribution. Most significant departs from normal distribution are observed in variables: FKRSMX, MLEDMAX, MLEDSMX, MPRLAG, SIGMAN, FIGMAN and FLEDSMX. Statistics of derived variables shows that all those variables have approximately normal distribution. Due to such notable depart from normal distribution some directly measured variables are excluded in further multivariate statistical analysis. However, for the purpose of reference, values of statistics of all measured variables are presented.

This analysis shows (Table 2) that during a game, a second line attacker spends on average 444.13 seconds in game (clean time). He swims 220.41 meters, of which 99.15 meters in sub maximal and maximal intensities (MMXSMX). At low intensity, a second line attacker swims on average 120.99 meters (MLAGAN). With player more or player less, he spends on average 43.06 seconds per quarter (SIGVM). In the duel, he spends 7.23 seconds (SDUEL). In the vertical posture and at maximal load, a second line attacker spends in total 50.59 seconds (SDUEL+SIGVM), which is about 11% of his playing time[13–14].

From the correlation matrix of variables (Table 3), a wide range of values is noted, from zero correlation variable of FLAGAN with MMXSMX and FMXSMX, to high correlation of variable FDUEL with variables SDUEL and FIGVM. Variable FIGVM is highly correlated with variables FDUEL (0.90) MDUEL (0.84) and FLAGAN (0.45). A group of variables SUKUPNO, FMXSMX, MMXSMX, MLAGAN and FIGM is high positive correlated with variable FAKCIJA, as well as the variables SUKUPNO, MMXSMX, FLAGAN, MLAGAN and FAKCIJA have high positive correlations (from 0.60 to 0.81) with variable METARA. It is noticed that variable SUKUPNO with mainly all variables have correlation over (0.50).

Three factors retained in analysis as most important, according to Gutman-Kaiser criterion, explain 84.6% variance of the total system variance.

The first factor is defined by variables with high positive projections of variables: FLAGAN, MLAGAN, METARA, FAKCIJA and SUKUPNO (0.94, 0.91, 0.88, 0.85 and 0.79), and with somewhat lower but significant coefficients of variables FIGVM (0.49) and SIGVM (0.44) which is consequence of amount of time spent in game. This factor is predominantly defined by measures of amount of the lower intensity in game. Thus, this factor is called *quantity of actions*. On this factor, we can recognize a typical mobile second line attacker, which is defined by a large quantity of swimming, dominantly in low intensity and great number of actions.

TABLE 2
CENTRAL AND DISPERSIVE PARAMETERS

Variable	X	SD	Kurtosis	Skewness	Min.	Max.
FKRMX	2.47	1.96	–0.34	0.61	0	7
FLEDMX	0.06	0.23	13.28	3.87	0	1
FKRSMX	6.38	3.70	–0.82	0.38	0	15
FLEDSMX	0.55	0.94	2.61	1.80	0	4
FKRLAG	10.70	4.85	0.20	0.43	1	26
FLELAG	2.18	2.22	0.26	1.02	0	8
FPRLAG	1.55	2.04	2.10	1.62	0	9
FDUEL	1.52	1.90	1.11	1.37	0	7
FIGVIS	1.60	1.22	0.06	0.55	0	5
FIGMAN	1.54	1.23	2.70	1.29	0	6
MKRMX	26.56	21.64	0.28	0.81	0	96
MLEDMAX	0.20	0.80	14.88	4.01	0	4
MKRSMX	69.99	41.45	–0.86	0.31	0	168
MLEDSMX	3.03	5.84	9.48	2.75	0	34
MKRLAG	99.24	50.88	–0.63	0.40	7	220
MLEDLAG	12.00	13.76	1.24	1.36	0	56
MPRLAG	9.75	13.80	2.85	1.83	0	56
SDUEL	7.23	9.31	1.43	1.41	0	41
SIGVIS	21.52	18.08	0.36	0.73	0	78
SIGMAN	21.54	18.05	2.77	1.30	0	96
SUKUPNO	444.13	132.80	0.58	–1.27	0	540
FMXSMX	9.46	5.17	–0.22	0.51	1	24
MMXSMX	99.15	48.42	–0.40	0.28	8	222
FLAGAN	14.44	6.83	0.25	0.56	2	33
MLAGAN	120.99	58.38	–0.66	0.40	7	257
FIGVM	3.11	2.63	0.81	1.13	0	12
SIGVM	43.06	28.22	0.59	0.62	0	133
FAKCIJA	27.01	10.15	–0.34	–0.09	5	52
METARA	220.41	73,87	–0.07	–0.51	38	379

The second factor is dominantly defined by high projections of variables FDUEL, MDUEL, and FIGVM (–0.98, –0.95 and –0.96). With somewhat lower, but significant, projection this factor also define variable FAKCIJA (–0.49). This factor can be interpreted as *intensity of activity in the vertical body posture*. This type of second line attacker is defined as a mobile with the large number of duels on two meters and a large quantity of time spent in the game with uneven number of player in competing teams.

The third factor is defined by high positive values in variables FFMXSMX, MMXSMX (0.95, 0.95) and variables FAKCIJA, METARA and SUKUPNO (0.58, 0.54, 0.52) with somewhat lower projections. The dominant characteristic of this factor is *intensity and extensity of activity in horizontal body posture*, conditioned with a number of actions and with

TABLE 3
CORRELATION MATRIX OF VARIABLES USED IN THE FINAL ANALYSIS

	FDUEL	SDUEL	SUKUPNO	FMXSMX	MMXSMX	FLAGAN	MLAGAN	FIGVM	SIGVM	FAKCIJA	METARA
FDUEL	1.00										
SDUEL	0.95	1.00									
SUKUPNO	0.30	0.29	1.00								
FMXSMX	–0.04	–0.07	0.40	1.00							
MMXSMX	0.04	0.05	0.49	0.85	1.00						
FLAGAN	0.30	0.23	0.61	0.08	0.05	1.00					
MLAGAN	0.31	0.29	0.60	–0.18	–0.08	0.87	1.00				
FIGVM	0.90	0.84	0.39	0.02	0.07	0.45	0.43	1.00			
SIGVM	0.19	0.13	0.34	0.23	0.21	0.35	0.25	0.48	1.00		
FAKCIJA	0.41	0.34	0.71	0.57	0.48	0.83	0.61	0.58	0.48	1.00	
METARA	0.28	0.27	0.81	0.42	0.59	0.74	0.76	0.39	0.28	0.81	1.00

TABLE 4
FACTOR STRUCTURE, EIGENVALUES AND PERCENT OF EXPLAINED VARIANCE

Variable	Factor 1	Factor 2	Factor 3
FDUEL	0.32	–0.98	0.05
MDUEL	0.27	–0.95	0.03
SUKUPNO	0.79	–0.36	0.52
FMXSMX	0.18	–0.02	0.95
MMXSMX	0.23	–0.08	0.95
FLAGAN	0.94	–0.35	0.10
MLAGAN	0.91	–0.35	–0.10
FIGVM	0.49	–0.96	0.12
SIGVM	0.44	–0.34	0.33
FAKCIJA	0.85	–0.49	0.58
METARA	0.88	–0.33	0.54
Eigenvalues	5.30	2.38	1.63
Explained variance	48.2%	21.6%	14.8%

a total time spent in a game. This structure is typical for second line attackers who are rarely in duels but swim a lot, and are in search for chances to score.

It is evident that there is a source of variability related with intensity of activity of the second line forward during the game. In the intensity, two aspects are noted. A number or quantity of actions, defined by the first factor, demonstrates the first aspect and the second aspect is the level and type of activity defined by the second and third factor. It is interesting to note that the level of load (intensity) is not so much related to time spent in the game, as it is related to the vertical and horizontal body posture loads, in respect to water surface, during the game.

Conclusion

From a wide selection of variables measuring total activity of a second line

attacker in water polo game, it is possible to define a subgroup with satisfactory factor validity. This set of variables describes all important activity aspects and loads of a second line attacker position or role in game. The experiment is carried out in a controlled setting provided by standardized conditions in regard to entities observation (competition games of First national league), and competent trained officials made observations. A set of new 29 variables is used for measurements of amount, intensity and duration of activities of second line attacker role player during game quarter. For variables basic statistics, mean, standard deviation, kurtosis and skewness are calculated and presented as referral values. Subset of variables with approximately normal distribution was analyzed for the purpose of finding latent structure and in order to evaluate new set of variables by means of its factor validity. Three factors are found to be significant according to GK criterion and explaining 84.6% of source variance. Interpretation of factors as *quantity of actions* (1), *intensity of activity in the vertical body posture* (2), *and in horizontal body posture* (3) indicates specificity of water polo game. These specifications are important to body postures due to the water environment in which this game is played. Similar findings are present in experimental study of other player roles in water polo[12,13]. Such experimental findings, as type of kinesiological activity analysis, should be of referral usefulness for other studies, and can be used for planning and programming training procedures in water polo sport.

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ANALIZA INDIKATORA OPTEREĆENJA TIJEKOM IGRE U AKTIVNOSTI DRUGE LINIJE NAPADA U VATERPOLU

S A Ž E T A K

Vaterpolo, kao aktivnost, pripada kategoriji polistrukturalnih sportova složenog kretanja. Aktivnosti igrača u ulozi napadača druge linije promatrana je na uzorku natjecateljskih utakmica u prvoj nacionalnoj ligi. Cilj studije bio je definirati skupinu novih mjerenih varijabli u cilju objektivnog bilježenja količine, intenziteta i trajanja aktivnosti igrača te procjene putem kriterija faktorske validnosti. Na uzorku od 87 igrača, primijenjeno je 29 varijabli. Stručno i trenirano službeno osoblje napravilo je mjerenja. Osnovni statistički podaci za sve mjerene varijable prikazani su kao referentne vrijednosti različitih aktivnosti igrača. U faktorskoj analizi nađena su tri značajna faktora koji objašnjavaju 84,6% varijabilnosti, što je podskup multivarijatno normalno distribuiranih varijabli. Faktori su interpretirani kao: količina akcije, intenzitet aktivnosti u vertikalnom stavu tijela i kao intenzitet i ekstenzitet aktivnosti u horizontalnom stavu tijela. Kod zadnja dva faktora, za stav tijela je nađeno da je karakterističan u vaterpolu, zbog specifičnosti igre u vodi. Zaključeno je da su predložene varijable i procedura mjerenja dobro prilagođen i objektivan instrument za mjerenje energetskih aspekata analize kineziološke aktivnosti.