TIME ANALYSIS OF THE GOALKEEPERS' MOVEMENTS IN WATER POLO

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Abstract:

The aim of this study is to measure the frequency, the partial duration and the total partial duration of all the recognisable movements of a water polo goalkeeper. In addition, comparisons of the goalkeepers' mean work and rest time value between the winning and losing teams, as well as the mean values of the work to rest proportions were made. Fifteen top male goalkeepers were videotaped during the official games of the Greek A/1 division in the 1996 championship. The total duration of every movement was transformed into percentages of the Total Real Time (the total time the ball was in the field) and the Grand Total Time (Total Real Time plus time-outs and intermissions) of the game. The mean frequency value for each movement of all goalkeepers was as follows: Slow Swim 46±3, Pass 24±3, Ready to Swim 55±5, Hands Up 11±7, Jumping 35±8 and Fast Swim 7±4. The mean duration value of each movement was: Slow Swim 00:47.29 ±2.61 sec, Pass 00:06.12±0.77 sec, Ready to Swim 00:13.65±1.90 seconds, Hands up 00:01.51±0.39, Jumping 00:00.65±0.08. The mean percentage value of the duration of every movement to the Grand Total Time was: 63.32% for the Slow Swim, 3.78% for the Pass, 19.32% for the Ready to Swim, 0.44% for the Hands Up, 0.59% for Jumping, 0.57% for Fast Swimming and 11.98% for the Time of Rest, whereas the mean percentage value of the duration of every movement to the Total Real Time was: 69.70%, 4.74%, 23.61%, 0.53%, 0.72% and 0.70%, respectively. The comparison of the goalkeepers' mean work and rest time values, between the winning and losing teams, as well as the mean values of the work to rest proportions did not show any significant differences. These findings demonstrate that the result of the game does not depend on the time of pressing the goalkeeper, but on other factors.

Key words**:** *water polo, goalkeeper, movement analysis*

ZEITANALYSE DER BEWEGUNGEN DES TORWARTS IM WASSERBALL

Zusammenfassung:

Das Ziel dieser Studie war, die Häufigkeit, die partiale Dauer, sowie die gesamte partiale Dauer aller erkennbaren Bewegungen eines Torwarts im Wasseball zu messen. Es wurde auch ein Vergleich zwischen der durchschnittlichen Arbeits- und Ruhezeit der Torwärte bei den Siegern und bei den Verlierern gemacht, sowie zwischen den Durchschnittswerten des Arbeits- und des Ruheanteils. In den offizielen Spielen der griechischen A 1 Liga in der 1996 Meisterschaft wurden Videoaufnahmen von 15 Leistungstorwärte genommen. Die Gesamtdauer jeder Bewegung wurde in Prozente der gesamten realen Zeit (die Zeit, in der der Ball im Spiel war), sowie in Prozente der Gesamtzeit des Spieles (die gesamte reale Zeit plus Auszeit und Unterbrechungen) umgerechnet. Die durchschnittlichen Häufigkeitswerte jeder Bewegung aller Torwärte waren die folgenden: langames Schwimmen 46±3, Zuspielen des Balles 24±3, Vorbereitung fürs Schwimmen 55±5, Hände hoch 11±7, Springen 35±8 und schnelles Schwimmen 7±4. Die durchschnittlichen Dauerwerte jeder Bewegung waren: langames Schwimmen 00:47.29 ±2,61 Sekunden, Zuspielen des Balles 00:06.12±0,77 Sekunden, Vorbereitung fürs Schwimmen 00:13.65±1,90 Sekunden, Hände hoch 00:01.51±0,39 Sekunden, Springen 00:00.65±0,08 Sekunden. In Prozenten der Gesamtzeit berechnet, war die Durchschnittsdauer der Bewegungen wie folgt: langames Schwimmen 63,32%, Zuspielen des Balles 3,78%, Vorbereitung fürs Schwimmen 19,32%, Hände hoch 0,44%, Springen 0,59%, schnelles Schwimmen 0,57% und Ruhezeit 11,98%. Im Unterschied dazu, war die respektive Durchschnittsdauer derselben Bewegungen in Prozenten der gesamten realen Zeit berechnet, wie folgt: 69,70%, 4,74%, 23,61%, 0,53%, 0,72% und 0,70%. Der Vergleich der durchschnittlichen Arbeits- und Ruhezeit der Torwärte bei den Siegern und bei den Verlierern, sowie der Durchschnittswerte des Arbeits- und des Ruheanteils erwies keine statistisch

bedeutende Unterschiede. Die Ergebnisse zeigen, dass das Endergebnis des Spieles nicht vom Pressens des Torwarts, sondern von anderen Faktoren abhängt.

***Schlüsselwörter**: Wasserball, Torwart, Bewegungsanalyse*

Introduction

Optimal planning and programming of training practice in water polo should be based on the analysis of competition activity and physiological demands of the game, as well as on the information on the motor status of athletes which is established by means of measuring and testing. A number of authors have examined the structure of movement and the biological reactions of the body which were characteristic for athletes practicing team sports such as football, American football, ice hockey, handball etc. Research studies of this kind aimed at determining objective indicators related to real physiological demands of water polo were but a few. The methods used in describing body and biological demands of team sports consisted of the analysis of basic movements during the game, as well as determining body and biological reactions by means of pulse measurements and the value of blood lactates (McInnes et al., 1995; Reilly and Thomas, 1976).

The first attempt to assess the requirements of water polo was made during some races with the use of a distance – pulse – counter and the analysis of the relationship between heart rate and VO_2 during free style swimming (Goodwin & Cumming, 1966). Lilley (1982) tried to analyze the requirements of the game by showing in a table the distances and the speed (which were defined subjectively) that Australian players of national level swam during a whole game. The conclusion was that the attacking players had covered almost 1,000 metres. The defenders covered almost the same distance and the center back players smaller distances than the two other types of players. Despite all these, the time and the intensity were recorded only for the goalkeepers and not for the players. Pinnington et al. (1986) conducted an expanded research which offers unique information to literature as far as the intention and the duration of the game are concerned. Although these data are indicative of the intensity of the game, they have limited application because of the changes in the regulations of the game. These results are also of limited value because the elements represent the average of all players, without offering any information about the duration and the frequency of certain activities of isolated players of different positions with specific roles such as the goalkeeper's role. All these pieces of information were collected from friendly games.

Gathering the information related to physiological demands placed on athletes during the national and international championships was quite limited, and the data acquired in this way frequently were not functionally or significantly connected to the obtained sports results. Videotaping of players during a game can provide information about the quantitative structure of motor activities when viewed from the load intensity aspect. In particular, when the ball or the center of the game are observed rather than a player, certain relevant data can be revealed, namely: duration, intensity and frequency, as well as the swim distances and speed of locomotion in water. Specific tasks required from players of various positions can be evaluated through their duration and frequency, but also through the type and intensity of activities during the game observed in relation to breaks between loads. This kind of quantitative analysis is very useful to a coach since he is the one who chooses and projects real training plans and programs for work for different positions in a team (Dopsaj & Matković, 1994).

An attempt to analyze competition activity by means of analyzing videotaped games was done by Smith (1991). This analysis was aimed at comparing the differences in frequency and scope of load observed in the categories of goalkeeper, center, inside defender and wings by means of analyzing natural elements of play. The analysis of competition activity in this study was done by observing the play of 4x7 mins. of "actual playing time" and before the last changes in the rules. Water polo organized by FINA was played for 4x9 mins. at national level, and 4x7 mins. at international level. Therefore, a reasonable question that someone could raise is what is the frequency, the average duration, the total duration and the intensity of the goalkeeper's activities in a game of 4x9 mins. duration.

The aim of this study was to categorize competition activities and quantify the basic movement of a goalkeeper during a game lasting 4x9 mins. and to estimate the intensity of the goalkeeper's play in relation to the subjective scalar of the activities' intention. In addition, the following assumptions were examined: 1) the total work time of the goalkeepers whose teams were defeated lasted more than the time of the winning teams and 2) the ratio of work and rest in the goalkeepers of the defeated teams is smaller than the ratio of the work and rest of the goalkeepers of the winning teams.

Methodology

Sample structure

The research was conducted by analyzing the competition activity of nine goalkeepers, three of which were members of the national team participating in 15 games. One goalkeeper was recorded five times, two of them twice, and the remaining six only once. Fourteen recordings from seven A1 category games were made with two cameras (one for each goalkeeper), while only one camera was used to tape the rest of goalkeepers.

Methods

Each goalkeeper was continuously taped during a game by a Panasonic MS-4 video camera. The recording was analyzed frame by frame with the precision of 0.04" (25 pictures per second) by a video camera Hitachi M 384. This device made frame-by-frame reproduction possible, as well as the reproduction at the chosen speed, both forward and in reverse, which enabled one to exactly follow and analyze the goalkeeper's movements. The reliability of the motor activities of goalkeepers in competition conditions was provided by repeating the analysis of movements twice and comparing the registered results.

The motor activity of a goalkeeper during a game was observed according to the following six models:

1. *Jumps:*
   This motor activity is characterized by movements with a simultaneous push away by the legs and body with one or both arms expelled from the water. The measurement of this activity begins at the moment the goalkeeper's hand comes out of the water until the elbow is plunged into the water again after a bounce.
2. *Hands up:*
   This motor activity is characterized by a direct extension of an arm from the water near the body without any previous bounce. The measurement of this activity begins from the moment when the goalkeeper's hands come out of the water until they are plunged back into the water again.
3. *Ready to jump – "alert":*
   This is a motor activity of swimming "on the spot". The motor activity of this type is characterized by a high body position and fast movements of the arms and legs as compared to swimming in one spot without any pressure.
4. *Fast swimming (Swim for the ball):*
   This is a motor activity of maximal intensity performed when the ball is taken from the offence, or the ball reaches a certain spot in the field and is passed quickly to a team member.
5. *Passing:*
   This motor activity starts from the moment the goalkeeper catches the ball in his hands until the moment he releases it, i.e. when he passes it to a member of his team.
6. *Slow swimming:*
   This is a low-intensity activity characterized by swimming without contact with an opponent or fighting for the ball. Slow swim was chosen only in the cases of a low-intensity motor activity when the goalkeeper was not pressured by the opposing players.

For each of the above models of the goalkeeper's physical activity in a competition, duration, frequency, as well as percentages in relation to the total time were determined. In addition, the duration of each of these motor activities in relation to the real time of the activity was determined and presented in percentages.

Furthermore, there is also a reference to the duration of the game, to the resting time, to the ratio of work: rest and the percentage of work of the goalkeeper taking into account the time of relaxation between the periods or the time-outs.

Total time refers to the time that the subject was in the pool, including all stoppages in play such as time-outs, penalties, corners and relaxation between the periods. Rest between the periods refers to the time between the 4 periods. Real time refers only to the time during which the game clock was running and the ball was in play without a time-out and the relaxation between the periods. Moreover, in comparison between the average of the whole work, the rest and the work-rest-ratio: a) as time of work, the time that the ball was in play in front of the goalkeeper was measured, in which the goalkeeper was under pressure; it included the actions: "ready to jump", "jumps", "hands up", "fast swimming" and "passing" and b) as time of rest, the time that the ball was in front

of the opponents' goal was measured (the goalkeeper was not under pressure) and it included the actions: "slow swimming", the time-outs and the time between the periods.

Categorization of load intensity on the basic models of goalkeeper's motor activities on a five-degree scale of expert effort evaluation is presented in Table 1. Jumps, hands up, and readiness to swim are considered as high intensity movements; swimming for the ball is a medium-high intensity movement; pass is considered as a medium intensity; slow swimming is considered low intensity, and the time between time outs and the 9th minute is considered as rest.

Applied statistical methods

As far as the average duration, the total duration and the frequency of variables are concerned, a descriptive statistical analysis by determining mean values and the corresponding standard deviation of the registered results was undertaken for all variables. Student's *t*-test for independent samples adjusted to the size of the sample was used to examine the significance of the noted differences between the goalkeepers of the defeated and the winning team according to:

1) the time of work
2) the time of rest
3) the work : rest ratio.

With regard to the reliability of the measurement of duration and frequencies the ICC method and the error method were used while r is Kendall's correlation coefficient between the indicators of duration and length.

Results

The reliability of measuring the duration and frequency of each movement is presented in Table 2. One can notice that high values of correlation (ICC) were achieved in both cases except in slow swimming and readiness to "jump" out of water. It can also be noticed that the values determined by the method of error were within the scope from low to medium, with the exactness of duration and frequency measurements. According to these results, it can be concluded that the measurements were reliable for both categories.

Table 1. Categorization of load intensity on basic models of goalkeepers' motor activities according to expert analysis.

Motor activity models	Subjective difficulty	Expert evaluation of load
1. Jumps	5	high intensity
2. Hands up	5	high intensity
3. Ready to jump	5	high intensity
4. Fast swimming (swim for the ball)	4	medium-high intensity
5. Passing	3	medium intensity
6. Slow swimming	2	low intensity
7. Time between 9' and timeouts	1	rest

Table 2: Reliability of duration and frequency measurements.

Models of motor activities	Duration		Frequency		r
	method error	ICC	method error	ICC	
1. Jumps	5.2%	0.95	9.3%	0.87	0.95
2. Hands up	3.8%	0.97	8.2%	0.85	0.90
3. Ready to jump	8.6%	0.86	7.8%	0.83	0.82
4. Fast swimming	3.3%	0.97	2.8%	0.95	1.00
5. Passing	3.2%	0.99	2.4%	0.99	1.00
6. Slow swimming	9.7%	0.84	2.6%	0.98	0.80

The method error is calculated as a variation coefficient between the subjects (the relation of standard deviation calculated from residual medium square in variance analysis and medium values of the measured values),

and **ICC** is an interclass correlation coefficient, while r is Kendall's correlation coefficient between the indicators of duration and length.

The average of the total duration in 8 games was $\bar{x}$ =64:23.16 ± 4:45.03, while the duration of the real game was $\bar{x}$ = 52:44.44 ± 3:38.16, which represents 81.96% of the total game duration. Furthermore, the duration of the game including the time-outs (4:00.18 ± 2:07.78), without including the rest between the periods was $\bar{x}$ = 56:44.65 ± 4:36.64, and the duration of the game including the rest between the periods (7:39.16 ± 0:24.25) without the time-outs was $\bar{x}$ = 60:23.98 ± 3:46.21.

As far as the time of work and the time of rest of the goalkeepers during the game and the ratio of these two parameters are concerned, it was found that the time of work of the goalkeepers was $\bar{x}$=15:50.40 ± 1:50.21 while the time of rest and the ratio of work : rest appear in Table 3. It is obvious that the time of work is much shorter than the time of rest.

Table 3. The average duration of rest and the ratio of work: rest (N=15) of goalkeepers.

	Resting time	Work:rest
Total rest	48:21.50 ± 4:05.02	1/3.09 ± 0.42
Real rest	36:33.20 ± 2:40.89	1/2.35 ± 0.32
Real rest and period rest	44:13.00 ± 2:52.15	1/2.83 ± 0.37
Real rest and time out	40:41.70 ± 3:54.60	1/2.60 ± 0.37

The same conclusion emerges from the percentage of work of the goalkeeper in relation to the total duration of the game which was $\bar{x}$ =24.70 ± 2.54%, while in relation to the duration of the real game it was $\bar{x}$=30.03 ± 3.02%. The percentage of the work in relation to the total duration without including the time-outs was $\bar{x}$ =26.36 ±2.53% and the percentage of work in relation to the total time without including the time of rest between the periods was $\bar{x}$ = 28.06 ± 2.89%.

Mean values of total duration of activities, frequency and average duration of each separate motor activity of goalkeepers, together with corresponding standard deviations are presented in Table 4.

Table 4: Descriptive indicators of duration and frequency of goalkeepers' movements (n=15).

Movement	Quantity	Mean value	Standard deviation
1. Jumps	Aver. total time(sec)	22.69	6.65
	Aver. frequency	35	8
	Aver. duration (sec)	0.65	0.08
2. Hands up	Aver. total time(sec)	16.39	11.92
	Aver. frequency	11	7
	Aver. duration (sec)	1.51	0.39
3. Jumps + Hands up	Aver. total time(sec)	39.08	9.50
	Aver. frequency	45	6
	Aver. duration (sec)	0.86	0.16
4. Ready to jump	Aver. total time(min)	12:23.50	1:37.55
	Aver. frequency	55	5
	Aver. duration (sec)	13.65	1.90
5. Fast swimming	Aver. total time(sec)	22.40	12.22
	Aver. frequency	7	4
	Aver. duration (sec)	3.19	0.71
6. Passing	Aver. total time(min)	2:25.49	22.85
	Aver. frequency	24	3
	Aver. duration (sec)	6.12	0.77
7. Slow swimming	Aver. total time(min)	36:03.10	2:40.97
	Aver. frequency	46	3
	Aver. duration (sec)	47.29	2.61

Table 5: Separate activities of goalkeepers presented in percentages in relation to the total time and the real time of the game (N=15).

	Slow swimming (%)	Passing (%)	Ready to jump (%)	Hands up (%)	Jumps (%)	Fast swimming (%)	Rest (%)
Total time	63.32±2.61	3.78±0.58	19.32±2.34	0.44±0.32	0.59±0.18	0.57±0.27	11.98±0.8
Real time	69.70±2.69	4.74±0.84	23.61±2.63	0.53±0.40	0.72±0.21	0.7±0.35	

Mean values of the total sample (n=15) in percentage of duration of separate activities viewed in relation to the total time of the game is shown in Table 5.

According to the registered mean values of the total sample, considering the expert evaluations of the intensity of load presented in Table 2, an evaluation of the intensity of the goalkeeper's performance can be made. A goalkeeper works intensively for 20.35% of the total time of the game, 0.57% with medium-high intensity, 3.78% with medium and 75.30% with low intensity or resting.

The analysis of the games shows that 24.89% of real time is spent in high intensity activities, 0.70% in medium – high intensity, 4.75% in medium intensity and 69.78% in low intensity.

The following values were acquired by means of comparison using *t*-test differences in mean values related to measuring total work, rest and the relation between work and rest of goalkeepers of defeated and winning teams. As regards the work, the goalkeepers of the defeated teams played less $\bar{x}$=15:14.41±1:54.81 sec. versus $\bar{x}$ =16:05.53 ± 1:39.12 which is the time that the goalkeepers played in the winning teams with no essential difference in t=0.892, as for the rest $\bar{x}$ = 36:29.31 ± 2:34.89 and $\bar{x}$ =36:42.94 ± 6:09.74, correspondingly with t=0.148, for the work : rest ratio of the total time the goalkeepers of the defeated team $\bar{x}$=3.24 ± 0.46, while for the goalkeepers of the winning teams $\bar{x}$=3.00 ± 0.37 with t =1.072 and the work : rest ratio of real time $\bar{x}$=2.44 ± 0.34 and $\bar{x}$=2.25 ± 0.31 correspondingly with t=1.097. None of the stated *t*-values has exceeded the threshold of significance (t=1.782, p<0.05).

Conclusion

This study presents an overall view of the characteristics of motor activities of male water polo goalkeepers during top games. The game of water polo, in spite of the fact that it is played in the water, in most cases lasts more than an hour and is similar to other games such as basketball and handball. The goalkeeper's play can be described by alternations in duration of action and rest. The relation between the duration of work and rest is high. A goalkeeper works very little 1/3.09 ± 0.42 in relation to total rest, while in relation to rest of the real time of the game he works 1/2.35 ± 0.32 (Table 3). Considering the percentage of work in relation to the real time of the game, we can see that the goalkeeper does little work. The total time of the goalkeeper's work in relation to the total duration of the game is very little when compared to the total duration of work in relation with real time. The total time of work in the first case is 24.70% of the total time and in the second case it is 30.03%. Characteristics of movement during real time should be taken into consideration, since they provide a more precise indicator of motor demands, independent of the frequency of time-outs, rests and other game interruptions. In Smith's (1991) study and in this present one the time that the goalkeeper is at work appears very short in relation to rest and the duration of the total game and to the real time of the game.

The obtained results point to the fact that the play of the goalkeeper as it appears by the frequency of the movements which were recorded (178 ± 8) is characterized by a small number of separate movements which have a different

duration and intention which keeps changing during a game. Two actions that are used repeatedly and last longer in the game are the "ready to jump - alert" (55 times) and "slow swimming" (46 times) which represent about 93% of the whole game. The rest that is 7% is used for movements with a small duration ($\bar{x}$=0.65, $\bar{x}$=1.51 sec) and high intensity like "jumps", "hands out" and movements of high and medium intensity such as fast swimming and passing which last for a few seconds ($\bar{x}$=3.19, $\bar{x}$= 6.12 sec). These short and intensive movements and the "ready to jump", which is an action of high intensity and average duration of 13.65 sec, are performed consecutively for about 35 sec each, and they alternate with low intensity spaces of about 46 sec. (slow swimming). By measuring the lactic acid of the goalkeepers it appeared that its level during the game was low, around 5-6 mmol/l (Rodriguez, 1994). It appears that low intensity spaces allow a partial recovery of the energy resources of the goalkeepers. In addition, from the afore-mentioned, it can be concluded that, apart from the explosive power necessary for a goalkeeper to undertake short movements, competition activity also calls for strength endurance, so as to endure the loads of longer duration and high intensity, such as ready to jump. Regarding swimming endurance in the horizontal position it appears that goalkeepers do not need it since, according to the results, the total swimming time during the game and the mean duration of the horizontal swimming is very short. Therefore, it is suggested that coaches should avoid endurance training with long duration and long distance high-intensity swimming for top-level goalkeepers, because this will decrease their useful training time. Goalkeepers should be trained with short distance high intensity bouts of exercise. According to the expert evaluation of degree of tiredness it can be noticed that 20.35% of the total time a goalkeeper performs with high intensity, 0.57% with medium-high intensity, 3.78% with medium and 75.30% with low intensity and rests. Indicators of goalkeeper's intensity are different when observed in relation to real time. As is seen from the same table, 24.86% of real time a goalkeeper works at high intensity, 0.70% at medium - high intensity, 4.74% at medium intensity and 69.70% at low intensity. Thus, higher degrees of high intensity and lower degrees of low intensity have been registered. Characteristics of motor activity during real time give a more accurate indicator of motor demands for game situations regardless of the frequency of time-outs, rest or other game interruptions.

According to the comparison of mean values of the total time of work, rest, real time duration and the relations among these values between goalkeepers of defeated and winning teams, statistically significant differences have not been noticed ($p>0.05$). The total time of the work of the goalkeepers of the defeated team is not greater than the time of the goalkeepers of the winning team and the ratio of work : rest for the goalkeepers of the defeated teams is not less than the ratio of work : rest for the goalkeepers of the winning team. This result underlines that the effectiveness of the goalkeepers does not depend on the time of pressing the goalkeeper, but on other factors. The effectiveness of a good goalkeeper is probably due to his ability to foresee the actions of the forward players, the quality of the performance of certain movements (e.g. synchronism, speed, height, angle, body position) or the ability of players to score.

The limitations of the present study can be as follows:

a) Lack of objective determination of intensity percentages (though pulse control or the biochemical analysis of blood samples could be possible solutions).
b) intensity, frequency and duration of each activity of a goalkeeper may vary from one game to another depending on the importance of the game, game strategy, variations of the result, level of competition, defense system and arbitration.

The data of this study should be applied to athletes of similar value and games of similar level and could provide water polo coaches with guidelines so as to evaluate more easily the situation elements of a goalkeeper's performance and create appropriate training loads accordingly.

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ANALIZA KRETANJA VRATARA U VATERPOLU

Sažetak

Optimalan plan i program treninga u vaterpolu mora se temeljiti na analizi natjecateljske aktivnosti i fizioloških zahtjeva igre te na informacijama o motoričkom i funkcionalnom statusu sportaša do kojih se dolazi mjerenjima i testiranjima. U brojnim su radovima istražene kretne strukture i tjelesne, motoričke i fiziološke, reakcije sportaša u momčadskim sportovima poput nogometa, ragbija, hokeja na ledu, rukometa, košarke i drugih. Slična istraživanja vaterpolske igre, u kojima se utvrđuju objektivni pokazatelji i njihove relacije sa stvarnim fiziološkim zahtjevima, malobrojna su.

Cilj je ovog istraživanja bio grupirati natjecateljske kineziološke aktivnosti i kvantificirati osnovne kretne strukture koje izvodi vratar tijekom utakmice u trajanju od 4 x 9 minuta, kao i procijeniti intenzitet vratarove igre na temelju samopercepcije i samoprocjene uloženoga napora. Postavljene su slijedeće hipoteze: 1) ukupno "radno vrijeme" vratara u poraženim momčadima duže je od aktivnosti vratara u pobjedničkim momčadima; 2) odsječci vremena u kojima se vratar odmara (akcija / odmor) kraći su za vratare u poraženim momčadima nego za vratere u pobjedničkim momčadima.

Materijal i metode

Analizirana je natjecateljska aktivnost devetorice vratara, članova prve vaterpolske grčke lige, od kojih su trojica članovi nacionalne vrste, na uzorku od 15 utakmica. Svaki vratar je tijekom utakmice neprekidno sniman video kamerom Panasonic MS-4, a kasnije je snimka analizirana "sličicu po sličicu" s preciznošću od 0,04'' (25 sličica u sekundi) video kamerom Hitachi M384.

Rezultati

Utakmice su ukupno, zajedno s predasima i odmorima između četvrtina, prosječno trajale 64' 23'' 16/100 ± 4' 45'' 3/100, a bez njih 52' 44'' 44/100 ± 3' 38'' 16/100. Od ukupnog trajanja utakmice na čistu igru otpada 81,96% vremena. Ukupno prosječno vrijeme tijekom kojega su vratari bili aktivni iznosilo je 15' 50'' 40/100 ± 1' 50'' 21/100, a prosječno vrijeme odmora, zajedno s predasima i odmorima između četvrtina, iznosilo je 48' 21'' 50/100 ± 4' 05'' 2/100, dok je bez njih iznosilo 36' 33'' 2/100 ± 2' 40'' 89/100. Relativno vrijeme vratarove aktivnosti u odnosu na ukupno vrijeme odmora iznosi 1/3,09 ± 0,42, dok je u odnosu na odmor tijekom čiste igre vratar aktivan 1 / 2,35 ± 0,32 vremena. Prosječna frekvencija, standardna devijacija, trajanje i postotna vrijednost svake kretne strukture prikazana je u tablici:

KRETNA STRUKTURA	FREKVENCIJA	TRAJANJE	% UKUPNO VRIJEME	% ČISTA IGRA
SKOKOVI	35 ± 8	0" 65/100±8/100	0,59%	0,72 %
PODIGNUTE RUKE	11 ± 7	1" 51/100±39/100	0,44%	0,53 %
PRIPREMA ZA SKOK	55 ± 5	13" 65/100±1" 90/100	19,32%	23,61 %
DODAVANJE	24 ± 3	6" 12/100±77/100	3,78%	4,74 %
BRZO PLIVANJE	7 ± 4	3" 19/100±71/100	0,57%	0,70 %
SPORO PLIVANJE	46 ± 3	47" 28/100±2" 60/100	63,32%	69,70 %
ODMOR			11,98%	

U usporedbi trajanja aktivnosti i odmora vratara pobjedničkih i poraženih momčadi nisu dobivene statistički značajne razlike.

Rasprava i zaključak

Istraživanje daje uvid u ukupnu aktivnost kvalitetnih vartepolskih vratara (muškaraca) tijekom utakmice. Dobiveni rezultati upućuju na to da se aktivnost vratara sastoji od relativno malog broja odvojenih kretnih struktura koje se javljaju s promjenljivom učestalošću, intenzitetom i trajanjem tijekom utakmice. Najčešće ponavljane akcije, koje su i najdulje trajale, bile su priprema za skok (55 puta registrirana akcija) i sporo plivanje (46 puta registrirana akcija). One predstavljaju gotovo 93% svih vratarovih akcija. Ostatak vremena (skoro 7%) troši se na kratkotrajne, ali vrlo intenzivne (skokovi, podignute ruke) ili srednje intenzivne akcije (brzo plivanje i dodavanje). Mjerenjem mliječne kiseline ustanovilo se da joj je razina tijekom igre u vratara relativno niska (5-6 mmol/l – Rodriquez, 1994). Čini se da razdoblja aktivnosti niskog intenziteta omogućuju djelomičan oporavak vratarovih energetskih izvora. Iz toga slijedi da natjecateljska aktivnost od vaterpolsog vratara traži, uz visoku razinu eksplozivne snage koja je potrebna za izvedbu eksplozivnih kretnih struktura, i visoku razinu snažne izdržljivosti.

Iz činjenice da nisu utvrđene statistički značajne razlike između vratara pobjedničkih i poraženih momčadi, može se zaključiti kako konačan rezultat utakmice i uspješnost/neuspješnost ne ovise o trajanju pritiska na vratara, već o drugim faktorima.

Ključne riječi: *vaterpolo, vratar, kineziološka analiza*