FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 5, Nº 2, 2007, pp. 109 - 120

Scientific Paper

THE ASSESSMENT OF THE ACQUISITION OF VARIOUS CRAWL STYLE MODES IN WATER POLO PLAYERS WITH RESPECT TO AGE AND COMPETITIVE LEVELS

UDC 797.253.4

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Abstract. *The research included 173 water-polo players aged 12 to 20, who were members of different water-polo clubs as representatives at the 1st national league level, and 187 players aged 11 to 20 who were members of different national water-polo selections from Serbia. The maximum time of swimming at a distance of 25 m was measured for every player whereby swimming meant using three different crawl techniques: 25m with the head under water - the basic technical skill level, 25m with the head above water - the directed skill level and 25m while leading the ball - the specific skill level. The results showed that there was a general, statistically significant difference among the given swimming tests and among the monitored samples in relation to the competitive level (Wilks' Lambda – 0.789, F = 31.11, p = 0.000), in relation to the age of the groups (Wilks' Lambda – 0.270, F = 49.12, p = 0.000) as well as in relation to the competitor category in the function of age groups (Wilks' Lambda – 0.920, F = 2.45, p = 0.004). By applying mathematical modeling by means of the method of smallest square numbers - the second-degree polynomial, models are defined which describe the regularity of the changes in the intensity of swimming at a distance of 25m from the aspect of the different crawl techniques regarding age and the competitive level.*

Key words: *water polo, water polo crawl, training process control*

1. INTRODUCTION

The aim of every coach, which he/she wants to fulfill during training, is to enable their sportsmen/women to be as successful as they can be in the sport activities they are involved in, that is, to achieve a higher level of the competitor efficiency. In water polo this means a much better and more successful, or more efficient performance of the ele-

Received February 28, 2007

ments of the game (techniques and tactics). By defining the basic factors which affect competitor efficiency, a structure of the space was obtained where the first place was occupied by movement performance regularity or the quality of the realization of a sport technique (Milišić, 2003).

In relation to water polo as a sports game which belongs to the group of Olympic Games, and the only one which is performed in water, the technique can generally be divided into the following:

– a basic technique which is realized in the horizontal position with or without a ball,
– a technique which is realized in the vertical position with or without a ball and
– a technique in a duel with a player with or without a ball (Smith, 1998).

Although players remain in the vertical position most of the time, a very important element of the technique is swimming crawl in a horizontal position (Dopsaj & Matković, 1994). In comparison with competitor swimming, during a water polo match, the crawl technique appears as a separate element of movement technique in many different modalities, primarily as - swimming crawl, crawl with the head above water, crawl while leading the ball as well as more variants of the specific water polo crawl (the technique consisting of doing the front crawl stroke with one's hands while the legs do the technique of the legwork in breaststroke (breaststroke kick), the technique of legwork scissors (scissors or snip kick) or the technique of legwork egg beater (egg beater kick) (Dopsaj & al., 2003[a]; Dopsaj & al., 2003[b]; Dopsaj, 2004).

During a match, a swimmer approximately swims between 925 and 1350m. Of all the swimming that is done, players swim about 11.25% (about 130-180m) of this length with maximum intensity, about 16.60% (about 180-250m) with sub-maximum intensity, about 35.50% (about 330-500 m) with mid intensity and about 31.25% (about 260-420m) with low intensity (Hohman & Frase, 1992; Dopsaj & Matković, 1994; Smith, 1998). Of all the swimming that is done, 89.53% of it is carried out using the crawl technique, and a distance of 280-430m (about 27.85%) is swum with maximum or sub-maximum intensity. Of the given percentage, players lead the ball in about 6.64% of situations. The data dealing with the structure of intensity while leading the ball in a match show that in 18.45% of the situations the ball is led by swimming with maximum intensity, in 12.09% of the situations it is led by swimming with sub-maximum intensity, while in only 6.87% of the situations players lead the ball swimming with mid or low intensity (Dopsaj & Matković, 1994; Pinnington et al., 1998). The aforementioned data indicate that swimming the crawl, primarily by the application of different modalities of the technique, is one of the most important elements of the technique which water polo players have to master. From the given modalities, swimming while leading the ball belongs to a very important technique which is mostly employed during a match with less than maximum intensity of strain (e.g. different kinds of counterattack).

The basic aim of this research is to establish the differences among the techniques of swimming the crawl with different modalities among water polo players of different ages and competitive levels. This will enable us to define the most characteristic modality of swimming in the function of age which determines the swimming ability of water polo players in relation to the anaerobic lactate energy system, that is, in relation to the absolute maximum speed of swimming. The second aim of this paper is to define the mathematical model with specific characteristics for the estimation of the different modalities of swimming the crawl with water polo players in relation to the different ages of players

and regarding the level of the competitor mastery. The given models will enable more efficient control and will enable us to monitor training effects which are applied in the training of water-polo players in relation to the monitored elements of the technique.

2. METHODS

2.1 The Sample of Subjects

The research included 173 water-polo players aged 11 to 20, who were members of different Serbian water polo clubs (WC Niš Classic, WC Partizan, WC Vojvodina, WC Red Star), as the representatives at the 1st national league level (CLUB Level Players) and 187 players aged 11 to 20 who were members of different national water-polo selections from Serbia (NATIONAL Level Players). The players were divided into five different age categories: under 12, 14, 16, 18 and 20 years of age. The whole testing was performed by the same team of researchers in the period from 2003 up to 2006 at national water polo camps as well as during the regular testing at clubs, or in other words at national selections. The basic descriptive indicators of the subjects in relation to the competitive level and age are shown in Table1.

Table 1. Basic descriptive indicators of subjects in relation to competitive level and age

Value Label			
AGE Groups	Club (N)	National (N)	Total (N)
12 yrs	46	49	95
14 yrs	54	66	120
16 yrs	31	26	57
18 yrs	20	22	42
20 yrs	22	24	46
Total	173	187	360

2.2 The Method of Testing

After the standard 600-800 m swim warm-up in a swimming pool, the players were tested on the set distance. The coach conducted all the measurements in an Olympic-sized swimming pool by means of a chronometric method. The testing was carried out by measuring with a stopwatch beginning with the start from water (Figure 1) until the top of the subjects' head would reach the imaginary half-distance line marking 25 m. The time needed for a 25 m swim with maximum intensity was measured for all of the players swimming three different techniques of crawl (Figure 2):

- 25 m with the head under water ($25m_{GD}$) - as a test which estimates the basic level of technical skill when swimming the crawl and represents the first level of motor complexity;
- 25 m with the head above water ($25m_{GG}$) – as a test which estimates the directed level of skill when swimming the crawl and represents the second level of motor complexity;

- 25 m while leading the ball ($25m_{LOP}$) – as a test which estimates the specific level of skill when swimming the crawl and represents the third level of the motor complexity (Dopsaj, 2004).

Fig. 1. The position of the start from water – 25 m while leading the ball (25_{Lop})

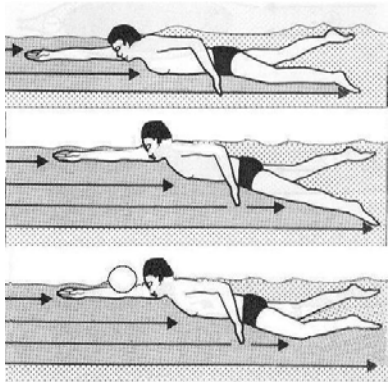


Fig. 2. Three different techniques of swimming the crawl

Pauses between the tests lasted at least 5 minutes and were of an active kind; in other words, the subjects swam the length of at least 75 meters after each test.

2.3 Methods of data processing

All the results were first processed using a descriptive statistic method with the aim of calculating the basic descriptive statistics and the tested variables from the aspect of the age of the tested groups. After the calculation of average values, the interdependence of the changes of these values in relation the age of the groups was defined. The calculation was performed by the application of mathematical modeling using the method of smallest square numbers - the second-degree polynomial. The models which describe the regularities in the changes to swimming intensity (represented as the time needed to swim the set distance) were calculated for a distance of 25 m from the aspect of the three different crawl techniques ($25m_{GD}$, $25m_{GG}$ i 25_{Lop}), while the age and the competitive level of the players (the first league representing the national level and the national team representing the international level) was taken into consideration.

In relation to the defining differences among the groups (2 groups), the applied tests (3 tests) and the age categories (5 age categories), the multivariate GLM (General Linear Model) method was used by the application of the criteria of repeated measuring (repeated measure criteria) according to the model 2 x 3 x 5. The standard criterion $p< 0.05$ (Hair et al., 1998) was used for the level of the statistical importance.

The SPSS 12.0 for Windows (Copyright©SPSS Inc., 1989-2003, Apache Software Foundation) statistical package and Microsoft®EXCEL 2003 (Copyright©1985-2003, Microsoft Corporation) were used for the application of the aforementioned methods of data processing.

3. RESULTS AND DISCUSSION

All of the results for the basic descriptive statistics of the three monitored variables regarding the groups of subjects are shown in Table 2 (Mean±SD).

Table 3 shows the matrix result of Box' test regarding the equality of covariance among the monitored samples on the basis of which we can determine that the sum sample is representative (Box' M = 655.38, F = 11.63, p sig. = 0.000) and that it can be used in the following multivariate step of data processing.

Table 4 shows the results of the GLM along with the values of Wilks' Lambda. On the basis of the results it can be said that there is a general and statistically significant difference among the given tests: among the studied samples in relation to competitive level (Wilks' Lambda – 0.789, F = 31.11, p = 0.000), in relation to age groups (Wilks' Lambda – 0.270, F = 49.13, p = 0.000) as well as in relation to competitor category in the function of the age groups (Wilks' Lambda – 0.920, F = 2.45, p = 0.004).

Table 5 shows the results of the GLM in relation to the effect of general differences among the subjects. On the basis of the results it can be maintained that among all of the variables in the function of the different competitive levels and age groups, a statistically significant difference was defined at the p = 0.000 level.

Table 6 shows the results of the Student's test that was used to estimate the partial difference in relation to the tested competitor groups in the function of age. On the basis of the obtained results it can be stated that among all of the variables in the function of a different competitive level and age group, a statistically important difference was determined at the p=0.000 level. In relation to the means of the values, which from a statistical point of view represents the position of the average values of groups given in standard deviation, it can be said that the biggest difference among the measured swimming tests was determined for the 14 year-old age group (t value = 8.57), while the smallest difference was determined in the 18 year-old age group (t value = 3.76). Hypothetically, such results can be regarded in the context of the assumption that the most important level of the initial selection (first level of selection) in water polo, from the aspect of top results at competitions, is the level of 14 year-olds, while the 18 year-old level can be taken as a starting point for selecting top water polo seniors.

Table 2. The results of the basic descriptive statistics of the three monitored variables regarding the groups of subjects

	CLUB Level Players				NATIONAL Level Players			
	Ages	$25m_{GD}$ (s)	$25m_{GG}$ (s)	25_{Lop} (s)	Ages	$25m_{GD}$ (s)	$25m_{GG}$ (s)	25_{Lop} (s)
12_{yrs} group	11.8±0.4	20.62±3.01	21.42±3.06	24.11±3.75	11.4±0.5	18.67±1.20	19.40±1.22	21.59±1.67
14_{yrs} group	13.6±0.5	17.30±2.50	17.81±3.02	19.41±3.91	13.6±0.4	13.92±0.82	14.30±1.02	15.00±1.13
16_{yrs} group	15.1±0.8	14.69±1.62	14.90±1.46	15.66±2.02	15.7±0.7	12.78±0.51	13.02±0.46	13.39±0.50
18_{yrs} group	17.5±0.6	13.93±0.92	14.09±1.04	14.65±1.73	17.1±0.6	12.66±0.56	12.95±0.60	13.36±0.72
20_{yrs} group	19.6±1.2	12.87±0.69	13.16±0.64	13.53±0.84	19.1±0.9	12.04±0.43	12.40±0.39	12.62±0.50

Table 3. Box's Test of Equality of Covariance Matrices[(a)]

Box's M	655.38
F	11.63
df1	54
df2	68407.66
p sig.	.000

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.
a Design: Intercept+comp_cat+ages_group+comp_cat * ages_group

Table 4. Multivariate Test results according to sub groups

Effect		Value	F	Hypothesis df	Error df	Sig.
comp_cat	Wilks' Lambda	.789	31.11	3.00	348.00	.000
ages_group	Wilks' Lambda	.270	49.13	12.00	921.01	.000
comp_cat * ages_group	Wilks' Lambda	.920	2.45	12.00	921.01	.004

Table 5. Tests of Between-Subject Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
comp_cat	$25m_{GD}$	260.08	1	260.08	93.12	.000
	$25m_{GG}$	259.14	1	259.14	78.61	.000
	25_{Lop}	389.19	1	389.19	72.57	.000
ages_group	$25m_{GD}$	2430.74	4	607.69	217.57	.000
	$25m_{GG}$	2814.51	4	703.63	213.43	.000
	25_{Lop}	4642.51	4	1160.63	216.43	.000
comp_cat * ages_group	$25m_{GD}$	76.35	4	19.09	6.83	.000
	$25m_{GG}$	90.52	4	22.63	6.86	.000
	25_{Lop}	150.13	4	37.53	6.99	.000

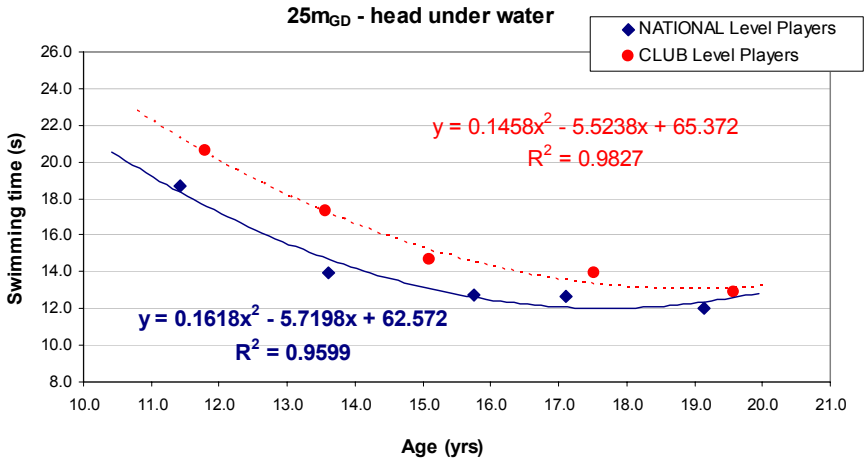
Table 6. Partial comparison differences
(Student t test: two sample assuming unequal variances)

Age groups	National Level Players vs Club Level Players			
	$25m_{GD}$	$25m_{GG}$	25_{Lop}	Average difference in t value
12 yrs	t = 4.12, p = 0.000*	t = 4.19, p = 0.000*	t = 4.18, p = 0.000*	t = 4.16
14 yrs	t = 9.51, p = 0.000*	t = 8.18, p = 0.000*	t = 8.03, p = 0.000*	t = 8.57
16 yrs	t = 6.23, p = 0.000*	t = 6.79, p = 0.000*	t = 6.03, p = 0.000*	t = 6.35
18 yrs	t = 4.60, p = 0.000*	t = 3.79, p = 0.000*	t = 2.89, p = 0.004*	t = 3.76
20 yrs	t = 4.83, p = 0.000*	t = 4.85, p = 0.000*	t = 4.42, p = 0.000*	t = 4.70

Based on observed group means. * The mean difference is significant at the .05 level.

Graph 1 shows the results of the defined models for the variable - $25m_{GD.}$ The obtained models have the following representation and intensity of prediction:

- $25m_{GDClub}$ – $y = 0.1458x^2 – 5.5238x + 65.372$, $R^2 = 0.9827$,
- $25m_{GDNnac}$ – $y = 0.1618x^2 – 5.7198x + 62.572$, $R^2 = 0.9599$.

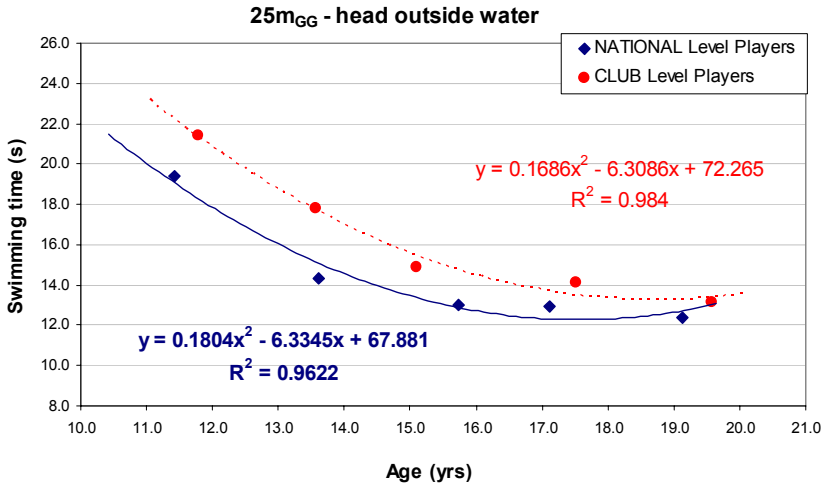


Graph 1. The results of the defined models for the variable - $25m_{GD}$ regarding the tested samples

The results indicate that in the case of the initial, or starting level of swimming intensity, the measured difference in the ability measured for the samples consisting of players at different competitive levels makes up 10.97% (differences in the first quotient of the function) and that the difference shows a tendency of decreasing to the level of 3.55% (the difference in the second quotient of the function). This means that the difference between the two given swimming abilities decreases with age and could point to the phenomenon that swimming with the head under water, as a basic style of swimming crawl and the measure of an overall physical training, is an ability that is more pronounced among the younger age categories. With older age categories the difference decreases (both national and club players swim well) which indicates the fact that competitor efficiency, that is, the quality of the game of the players in the given categories, depends on specific training and specific technical indicators. In other words, there is a possibility that the given test cannot be used as an individual test in the estimation of specific swimming training of water-polo players in the case of older age categories (over 18).

Graph 2 shows the results of the defined models for the variable - $25m_{GG.}$ The obtained models have the following representation and intensity of prediction:

- $25m_{GGClub}$ – $y = 0.1686x^2 – 6.3086x + 72.265$, $R^2 = 0.9840$,
- $25m_{GGNnac}$ – $y = 0.1804x^2 – 6.3345x + 67.881$, $R^2 = 0.9622$.

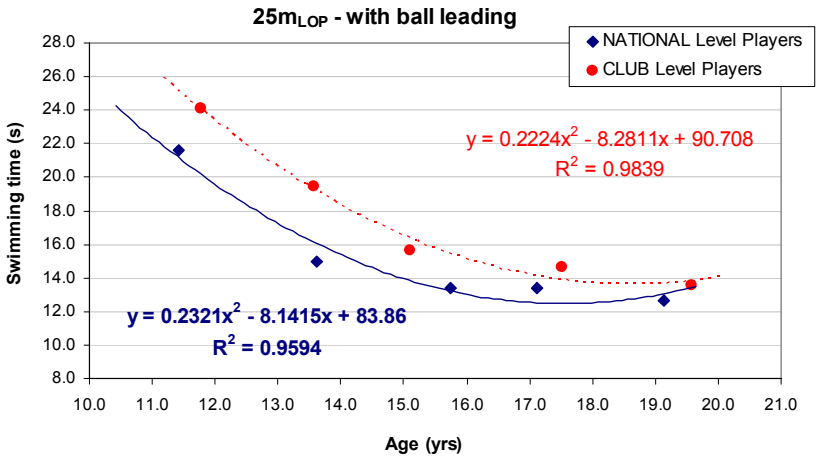


Graph 2. The results of the defined models for the variable - $25m_{GG}$ regarding the tested samples

The results indicate that in the case of the initial, or starting level of the swimming speed, the measured difference in the ability measured for the samples consisting of players at different competitive levels makes up 6.99% (differences in the first quotient of the function) and that the difference shows a tendency of decreasing to the level of 0.41% (the difference in the second quotient of the function). As in the case of the variable $25m_{GD,}$ this means that the differences in swimming abilities decrease with age, which could point to the phenomenon that swimming with the head above water, as the directed and more complex style of swimming than the basic style of swimming crawl and as the measure of an overall physical training, is an ability that is more pronounced among the younger age categories. The existing difference decreases with age (both national and club players swim well with the head above water), which points to the fact that competitor efficiency, or the quality of the game of the players in the given categories depends on specific training and specific technical indicators. In other words, there is a possibility that the test cannot be used as an individual test in the estimation of specific swimming training of water-polo players in the case of older age categories (over 18).

Graph 3 shows the results of the defined models for the variable - $25m_{LOP.}$ The obtained models have the following representation and the intensity of prediction:

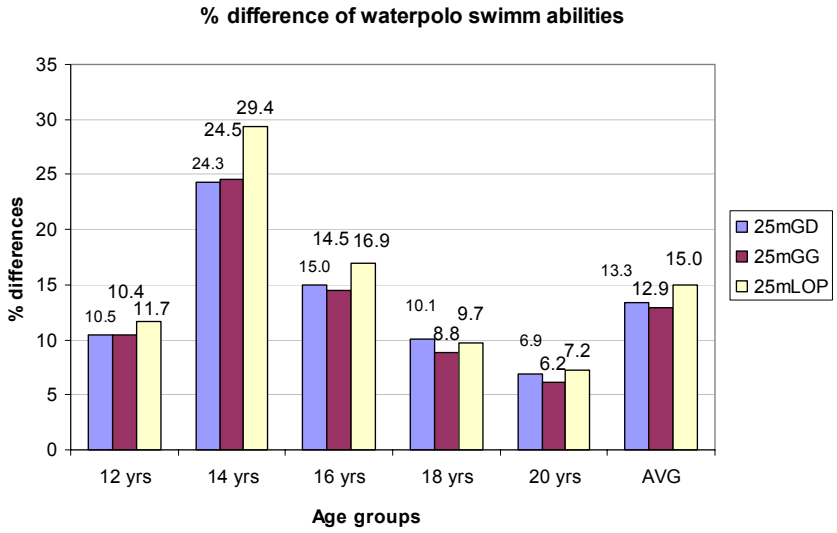
- $25m_{LOPClub}$ – $y = 0.2224x^2 – 8.2811x + 90.708$, $R^2 = 0.9839$,
- $25m_{LOPNnac}$ – $y = 0.2321x^2 – 8.1415x + 83.860$, $R^2 = 0.9594$.



Graph 3. The results of the defined models for the variable - $25m_{LOP}$ regarding the tested samples

The results indicate that in the case of the initial, or starting level of the swimming speed, the measured difference in the ability measured for the samples consisting of players at different competitive levels makes up 4.36% (differences in the the first quotient of the function) and that it shows a tendency of decreasing to the level of -1.69% (the difference in the second quotient of the function). As in the case of the variables $25m_{GD}$ and $25m_{GG}$, this means that the differences in swimming abilities decrease with age, which could point to the phenomenon that swimming while leading the ball, as a specific and more complex style of swimming than the basic and directed style, and therefore the most complex training level of water-polo crawl swimming, and as the measure of overall physical training, is an ability that is more pronounced among the younger age categories**.** In addition, only in the case of this technique of swimming the trend of change in skill level with age is smaller in the case of NATIONAL level players than CLUB level players. This emphasizes the fact that for all age categories the specific skill, defined as the maximum speed of swimming with the control of leading the ball, is a dominant category, that is, the category which is brought to a higher level of development. A higher level of initial development of some motor abilities conditions their slower development later on (Čoh et al., 2004). On the other hand, a swimming task in which tested groups show a minimum of difference, a difference which is essential in this case, practically represents the most discriminating test, and that is the test of water polo crawl swimming while leading the ball (Table 6, Graph 3). The given difference decreases with age (both national and club players swim well while leading the ball), which also points to the fact that competitor efficiency, or the quality of the game of the players in the given categories, depends on specific training and specific technical indicators, but in the more complex motor conditions of strain in water-polo. In other words, there is a possibility that the test can be used as an individual (single) test in the estimation of the specific swimming skill of older water-polo players (over 16), but cannot be used (it is questionable) as an individual (single) test in the estimation of the specific swimming skill of younger water-polo players (under 14).

Graph 4 shows the results of the differences (shown in %) between the samples (Club and Nat) regarding age and the monitored variables ($25m_{GD}$, $25m_{GG}$, $25m_{LOP}$). The average sum difference in relation to age is the following: 10.87% for the under 12 group, 26.07% for the under 14 group, 15.47% for the under 16 group, 9.53% for the under 18 group and 6.77% for the under 20 group. On the basis of these results it can also hypothetically be assumed that the age of about 14 can be treated as the first level of selection, that is, from the aspect of the measured abilities and the applied tests a conclusion may be drawn that the differences between club and national players (expressed in %) are the greatest at this age.



Graph 4. The results of the differences (shown in %) between the samples (Club and Nac) regarding age and the monitored variables ($25m_{GD}$, $25m_{GG}$, $25m_{LOP}$)

In addition, the results in sum clearly show that the differences between the groups regarding the competitive level, and from the aspect of the measured swimming tests are the greatest with the technically most complex style of swimming, that is, with swimming while leading the ball ($25m_{LOP}$ – 15.0%) in comparison to the other two tests ($25m_{GD}$ – 13.3% and $25m_{GG}$ – 12.9%; Graph 4 – all AVG). This shows that, if these tests were to be used in some future research in water-polo from the aspect of swimming abilities, it is methodologically justifiable to use the test of the 25 m swim with maximum intensity and leading the ball because its discriminating ability was proved to be greater than that of the other two tests.

Generally, by applying the existing models it is possible to reliably locate the measured ability of players in relation to their defined trend of development, both regarding age and the competitive level with 95.94% in relation to $25m_{LopNac}$ (Graph 3), and up to 98.40% in relation to $25m_{GGClub}$ (Graph 2). This points to the control of the efficiency of the applied training process of water-polo players' objective in view of the development of the maximum speed of a 25m-swim in relation to the three techniques of crawl.

Additionally, the results show that the greatest difference between the monitored samples – water-polo players, at the national level (the first league) and international level (national team) in relation to the measured variables – swimming 25 m with the head under water ($25m_{GD}$) as the basic level of training, and with the head above water ($25m_{GG}$) as the directed level and while leading the ball ($25m_{LOP}$), as the specific level of training, was found exactly at the third level, that is, the specific level of training as the sum difference – 15.0% while the partial difference was the greatest at the age of 14 – 29.4% (Graph 4).

4. CONCLUSION

It can be concluded that water-polo players at different competitive levels primarily differ in relation to the efficiency of the performance of the elements of the technique which are realized in specific motor conditions. On the basis of the obtained results, this conclusion applies to all age groups and competitive levels in water-polo.

Moreover, on the basis of the results it can hypothetically be assumed that the age of about 14 can be treated as the first level of selection, that is, from the aspect of the measured abilities and the applied tests a conclusion may be drawn that the differences between club and national players at this age are the greatest – on average 26.07%.

REFERENCES

1. Dopsaj, M., & Matković, I. (1994). Motorička aktivnost vaterpolista u toku igre (Motorical activity of water polo players during the game). *Fizička kultura*, 48 (4), 339-346.
2. Dopsaj, M., Manojlović, N., Bratuša, Z., & Okičić, I. (2003[a]). The structure of swimming skills in water polo players at the first level of pre-selection. *Exercise & Society Journal of Sports Science*, 34, 76-80.
3. Dopsaj, M., Manojlović, N., Okičić, T., Stojanović, S., & Vasilovski, N. (2003[b]). Function modeling of specific swimming water-polo players abilities in conditions of long-term training period: A transversal study, *Exercise & Society Journal of Sports Science*, 34, 323-330.
4. Dopsaj, M. (2004). Modeli za procenu generalne horizontalne plivačke pripremljenosti vaterpolo igrača uzrasta od 12, 14 i 16 godina (Models for estimation general horizontal swimming preparation of water polo players aged 12, 14 and 16). In D. Perišić (Ed.), *Seminar of young categories coaches proceedings* (pp. 3-14). Belgrade: Waterpolo assotiation of Serbia.
5. Pinnington, H.C., Dawson, B., & Blanksby, B.A. (1998). Heart rate responses and the estimated energy requirements of playing water polo. *Journal of Human Movement Studies*, 15, 101-118.
6. Hair, J., Anderson, R., Tatham, R., & Black, W. (1998). *Multivariate data analysis (fifth ed.)*. USA: Prentice – Hall, Inc.
7. Hohmann, A., & Frase, R. (1992). Analysis of swimming speed and energy metabolism in competitor water polo games. In D. MacLaren, & A. Lees. (Eds.), *Biomechanics and Medicine in Swimming – Swimming Science VI* (pp. 313-319). London: E & FN Spon.
8. Milišić, B. (2003). *Upravljanje treningom* (Management of training). Belgrade: SIP Publikum.
9. Smith, H. K. (1998). Applied physiology of water polo. *Sports Medicine*, 26 (5), 317-334.
10. Tumilty, D., Logan, P., Clews, W., & Cameron, D. (2000). Protocols for the physiological assessment of elite water polo players. In: Physiological Tests for Elite Athletes – Australian Sports Commission. Eds: Gore C.J. Champaign, IL: Human Kinetics. 411-421.
11. Čoh, M., Jovanović-Golubović, D., & Bratić, M. (2004). Motor learning in sport. *Facta Universitatis, Series Physical Education and Sport*, 2, 45-59.
12. Зациорски, В. (1982). *Спортивная метрлогия (Sports metrology)*. Москва: Физкультура и спорт.

PROCENA USVOJENOSTI RAZLIČITIH MODALITETA PLIVANJA KRAUL TEHNIKE KOD VATERPOLISTA U FUNKCIJI UZRASTA I TAKMIČARSKOG NIVOA

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U istraživanju je učestvovalo 173 vaterpolista uzrasta od 12 do 20 godina, članova klubova iz Srbije, kao predstavnika pet uzrastnih kategorija kluba iz I nacionalne lige i 187 igrača uzrasta od 11 do 20 godina koji su bili članovi pet različitih nacionalnih vaterpolo selekcija Srbije. Kod svih igrača je izmereno vreme za maksimalno preplivavanje deonice od 25 metara i to primenom tri različite tehnike plivanja kraul: 25m sa glavom u vodi – osnovni nivo tehničke obučenosti, 25m sa glavom van vode – usmereni nivo tehničke obučenosti i 25m sa vođenjem lopte – specifični nivo tehničke obučenosti. Primenom matematičkog modelovanja pomoću metode najmanjih kvadrata – polinomom drugog stepena, definisani su modeli koji opisuju zakonitost promene intenziteta plivanja na deonici od 25m sa aspekta različitih kraul tehnika u funkciji uzrasta i takmičarskog nivoa. Takođe, primenom multivarijatnih statističkih metoda utvrđeno je postojanje razlike srednjih vrednosti posmatranih varijabli u odnosu na takmičarski nivo i uzrastne grupe. Rezultati su pokazali da postoji generalna statistički značajna razlika između datih plivačkih testova između posmatranih uzoraka u odnosu na takmičarski nivo (Wilks' Lambda – 0,789, F = 31,11, p = 0,000), u odnosu na uzrastne grupe (Wilks' Lambda – 0,270, F = 49,12, p = 0,000), kao i u odnosu na takmičarsku kategoriju u funkciji uzrastnih grupa (Wilks' Lambda – 0,920, F = 2,45, p = 0,004).

Ključne reči: *vaterpolo, vaterpolo kraul, kontrola trenažnog procesa*