Swimming Capacities in High-Level youth Water Polo; Playing-Position Specifics

Plivačke sposobnosti vrhunskih vaterpolista juniora; specifičnosti prema pozicijama igrača

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Summary

The main objective of this study was to establish differences in swimming capacities between groups of water polo athletes, based on their primary involvement in four game-positions (Centres, Wings, Drivers and Points). The sample of respondents consisted of 82 high-level youth water polo youth players (aged 17 – 19 years, body height 186.3 ± 6.07 cm; body mass 84.8 ± 9.6 kg). The sample of variables included body height and body mass, and the following four tests of swimming abilities: sprint swimming over 25 metres, short-distance- swimming over 100 metres, anaerobic swimming capacity (swimming 50 – metres- four times (with 30s pause); and aerobic swimming capacity (swimming 400- metres). After reliability analyses, differences between the groups were established by means of an analysis of variance with Schefee post-hoc test where appropriate. Swimming capacities are found to be differentially associated with playing positions. While the Wings are superior in sprint - swimming, the Points dominated in short-distance- swimming-capacity. Playing- positions did not significantly differ in anaerobic - or aerobic-swimming- capacities. Professionals working with young athletes should be aware of these results and use the presented values as normative data.

KEY WORDS
swimming capacities in high-level youth water polo athletes
playing-position specifics

Sažetak

Glavni cilj istraživanja bio je utvrditi razlike u plivačkim sposobnostima među skupinama vaterpolista prema četirima primarnim pozicijama u igri (centar, krilo, lijevi ili desni vanjski, srednji vanjski). Uzorak ispitanika sastojao se od 82 vrhunska vaterpolista juniora (u dobi od 17 do 19 godina, visine 186.3 ± 6.07 cm, težine 84.8 ± 9.6 kg). U uzorku varijabli uključene su visina i težina te četiri testa plivačkih sposobnosti: plivanje u sprintu preko 25 metara, plivanje na kratke dionice preko 100 metara, anaerobno plivanje (dionica 4 puta 50 metara s pauzom od 30 sekundi) i aerobno plivanje (dionica 400 metara). Nakon analize pouzdanosti utvrđene su razlike među skupinama analizom varijance testom Schefee post hoc. Utvrđeno je da su plivačke sposobnosti diferencijalno povezane s pozicijama u igri. Dok su krila izvrsna u sprintu, srednji vanjski dominiraju u plivanju kratkih dionica. Nema značajnih razlika u anaerobnim ili aerobnm plivačkim sposobnostima. Stručnjaci koji rade s mladim sportašima trebaju na umu imati ove rezultate te se koristiti prikazanim vrijednostima kao normativnim podacima.

KLJUČNE RIJEČI
plivačke sposobnosti vrhunskih vaterpolista juniora
specifičnosti prema pozicijama igrača

1. INTRODUCTION / *Uvod*

Water polo is an Olympic team water sport which has been played for over a century. The game is oriented toward two goals positioned in the swimming pool, while the playing team consists of six field players and one goalkeeper. The offensive positions include: one Centre (a.k.a. two-metre offense, 2-metres, hole set, set, hole man, bucket, pit player or pit-man), two Wings (located on or near the 2-metre line), two Drivers (perimeter players, also called „flats", located on or near the 5-metre line), and one Point (usually just behind the 5- metre line), positioned farthest from the goal. Defensive positions are often positioned the same, but just switched from offence to defence. The winner of the game is the team that scores more goals (Melchiorri et al., 2010; Uljevic, Esco, & Sekulic, 2014). While the game – duties of each playing – position are relatively strict, in certain situations during the game athletes must switch between positions and present their polyvalence (i.e. capability of playing in different positions during the game) (Sekulic et al., 2015).

Water polo is a highly intensive sport with significant anaerobic energy metabolism, as blood lactate levels range from 5.3 to 11.2 mmol/l during a game, depending on the playing position. In short, the mean match blood-lactate concentrations for Centre Forwards (Centres) were 11.2 ± 1.0, mmol/l; for Centre Defenders (Points) lactate concentration was 6.7 ± 0.9, while for Field Players (Drivers and Wings) the lactate values were 5.3 ± 0.9 mmol/l (Melchiorri et al., 2010). Al together, this indicates a different physiological background for each water polo playing position. Namely, while Centres and Points are regularly in a certain contact game, wrestling for position, the outside players (i.e. Drivers and Wings) are relatively far from the goal, and therefore not often in a contact game with the opponent. As a result, a position-specific approach is evident in most studies so far conducted on water polo, regardless of gender and/or level of play (Botonis, Toubekis, & Platanou, 2015; Melchiorri et al., 2010; Platanou & Varamenti, 2011).

Since during the game athletes are constantly swimming (in either a horizontal, or semi-vertical position), swimming capacity is regularly observed as one of the most important fitness capacities in water polo (Lupo, Capranica, Cugliari, Gomez, & Tessitore, 2015; Tan, Polglaze, & Dawson, 2009). More precisely, due to the different game- duties, four types of swimming capacities should be differentiated: sprint swimming (over distance of up to 20 – 25 metres), short-distance swimming (up to 100 metres), -aerobic endurance, and anaerobic (i.e. lactate) endurance capacity (Kondric, Uljevic, Gabrilo, Kontic, & Sekulic, 2012; Sekulic et al., 2015; Sekulic, Zenic, & Zubcevic, 2007). Each of these capacities appears in certain game-situations. For example, sprint swimming is most common in a fast transition from offense to defence (or vice-versa). Short -distance swimming appears in a situation of a fast turn-over. Anaerobic endurance is a highly important quality in game-situations when athlete has to repeatedly swim for offense to defence after a turn-over, offensive fault, and/or a wrestling (contact) game. Finally, because a water polo game lasts four times 6 – 8 minutes, swimming aerobic endurance is highly challenged (V. Lozovina, Pavicic, & Lozovina, 2003). In general, studies have confirmed the importance of swimming-capacities in distinguishing more successful players from less successful ones (Idrizovic, Uljevic, Spasic, Sekulic, & Kondric, 2015) . However, studies have rarely investigated these capacities in relation to the different game- duties in the sport of water polo.

There are several possible explanations for such a lack of studies on the topic of position-specific differences in swimming capacities. First, while sprint swimming is a relatively convenient and non-time-consuming test procedure; aerobic- and anaerobic- endurance swimming are not popular due to their exhaustive nature (Idrizovic, Uljevic, Ban, Spasic, & Rausavljevic, 2013; Idrizovic et al., 2015). Consequently, testing is complicated and time-consuming. Second, and probably most importantly, the position-specific approach asks for a relatively large number of subjects. Namely, in most teams, there are only two Points and two Centres. Therefore, in order to achieve a proper number of subjects in each playing position, a large sample of subjects is needed (Kondric et al., 2012). As a result, testing of this kind is only feasible in regions (i.e. countries) where water polo is a relatively popular sport.

The aim of this study was to evaluate differences in four swimming capacities among players who are primarily involved in four game positions: namely, Centres, Wings, Drivers and Points. In addition, we established differences between playing positions in anthropometric indices (i.e. body mass, body height, body-mass-index and triceps skinfold). The increased knowledge on this issue will allow water polo coaches to precisely evaluate the importance of the different swimming capacities for each playing position in water polo sport, and consequently target the training and conditioning to certain game duties.

2. METHODS / *Metode*

2.1. Respondents / *Ispitanici*

The sample of respondents consisted of 82 high-level young water polo youth players (aged 17 - 19 years, body height 186.3 ± 6.07 cm; body mass 84.8 ± 9.6 kg). All players had been trained in water polo for at least 7 years. At the time of testing, they were participating in 8 – 10 training sessions per week (plus one game), with each session lasting about 2 hours. Morning training usually consisted of swimming, gym and technical-tactical exercising, while afternoon training comprised tactical exercises. We observed Centres (n = 16), Points (n = 19), Wings (n = 25) and Drivers (n = 26), while Goalkeepers were not included in this study.

2.2. Variables / *Varijable*

The sample of variables included body height and body mass, and four tests of swimming capacity. Body height was measured in cm by a stadiometer, while body mass was measured in kg using a digital weight scale.

Sprint swimming: The sprint-swimming commenced upon a sound signal and the subjects were not allowed to push off the pool wall. The water polo crawl position was performed during the test with the head remaining out of the water throughout and the athlete sprinted over a 15 m distance. A Longines (Saint-Imier, Switzerland) swimming timing apparatus was used. The best of three trials was retained as the final result for each participant.

Short-distance- swimming: swimming over 100 metres was used to define this swimming capacity. The test consisted of a 4 x 25 metre relay. A flip turn was not allowed, but the subjects were allowed to push- off the wall at the start and after a turn. A subsample of 21 athletes performed the test over three trials for the purpose of reliability analysis.

Anaerobic swimming capacity: During the anaerobic- swimming test, each subject swam at their maximum exertion over a 50 m distance four times with a 30 second recovery period between each interval. As a final result, the average time of the four 50-m trials was used.

Aerobic swimming capacity: This test consisted of 400 metres free- style swimming. The subjects were allowed to push off the pool wall but a flip- start was not allowed (i.e. some athletes are familiar with this technique, while others are not). The test was commenced only once. For the purpose of reliability analysis, a test-retest procedure was applied on the subsample of 21 subjects, with 7- days of rest between the test and retest.

Testing was carried out at three testing sessions. On the first day, the subjects were tested on anthropometrics, sprint swimming (25- metre swim) and aerobic endurance (400- metre- swim). On the second day, the subjects performed short-distance swimming (100-metres), while on the third day they participated in the anaerobic- endurance- test. The 21 subjects participated in the retest of aerobic- and anaerobic- endurance- swimming 7 days after the first (i.e. test) procedure. Testing was performed at the beginning of their season, after the summer break. Prior to testing, the subjects completed a 15-min convenient warm-up procedure, consisting of a dry land warm-up, and swimming over a distance of 200- metres, using different swimming techniques.

The subjects were classified as being Centres, Points, Wings and Drivers by their team- coaches.

2.3. Statistics / *Statistika*

For the purpose of reliability analysis, the coefficient of variation and intra-class-coefficient were calculated for sprint- swimming. For the tests of aerobic- and anaerobic- swimming- capacities we calculated a test-retest correlation, and the results were analysed through a Bland-Altman plot (Idrizovic et al., 2015).

The differences between playing positions in the observed variables were established by an analysis of the variance (ANOVA) with Schefee post-hoc analyses where appropriate (Kondric et al., 2012).

A 95% level of statistical significance was applied. Statsoft's Statistica for Windows ver 12.0 was used for the calculations.

3. RESULTS / *Rezultati*

The CV for sprint- swimming and short-distance- swimming showed relatively small intra-subject variations (CV = 3% and 4% for sprint- swimming- 25 m and swimming- 100 m). In addition, the ICC of 0.89 evidenced appropriate reliability of the measure of sprint- swimming capacity (Table 1).

As evidenced throughout the test-retest correlation, the reliability of the aerobic- and anaerobic- swimming test was appropriate (r = 0.87 and 0.82 for the aerobic- and anaerobic- endurance tests, respectively). According to the BA graphics (Figures 1 and 2), most of the results are projected within two standard deviations of the test-retest difference for both tests. Moreover, there is an equal number of subjects performing better and worse throughout the retest (i.e. a similar number of dots below and above the abscise line). Consequently, we can determine appropriate reliability of the aerobic and anaerobic- swimming tests applied herein.

Table 1 Descriptive statistics for measured variables and reliability analysis for swimming-capacities (CV – coefficient of variation; Test-retest r – Pearson's correlation between test and retest)

Tablica 1. Deskriptivna statistika za mjerene varijable i analiza pouzdanosti za plivačke sposobnosti (CV – koeficijent varijacije; prvi i ponovljen test – Pearsonov koeficijent korelacije (r) između prvog i ponovljenog testa)

	Mean	Minimum	Maximum	SD	CV	Test-retest r
Body height (cm)	186.30	173.00	204.60	6.07		
Body mass (kg)	84.82	63.00	112.00	9.65		
Body mass index (kg/m^2)	24.40	18.62	32.03	2.13		
Triceps skinfold (mm)	11.56	6.00	19.20	3.40		
Swimming-25m (s)	12.97	11.15	15.03	0.69	0.03	
Swimming-100m (s)	62.91	54.01	88.00	5.81	0.04	
Swimming-400m (s)	281.84	170.70	356.00	41.26		0.87
Anaerobic-endurance (s)	31.35	26.83	43.15	3.19		0.82

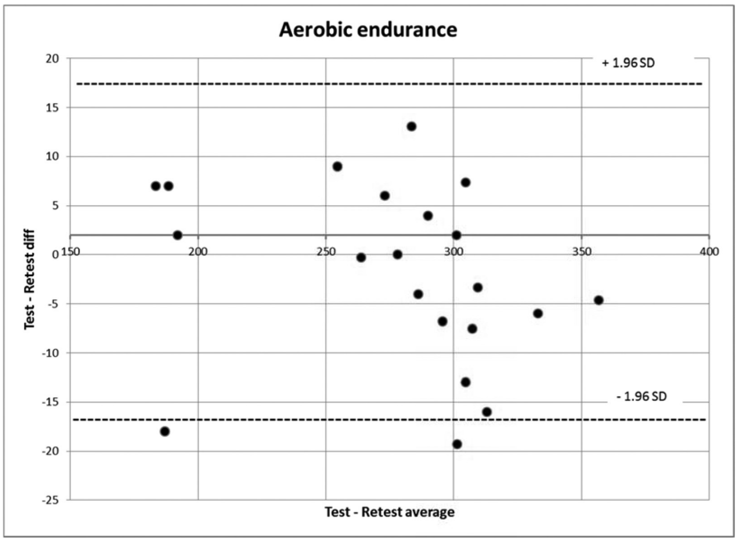

Figure 1 Bland Altman graphic of the test-retest average and differences for aerobic endurance test

Slika 1. Bland-Altmanov grafički prikaz srednje vrijednosti razlika prvog i ponovljenog testa za aerobnu izdržljivost

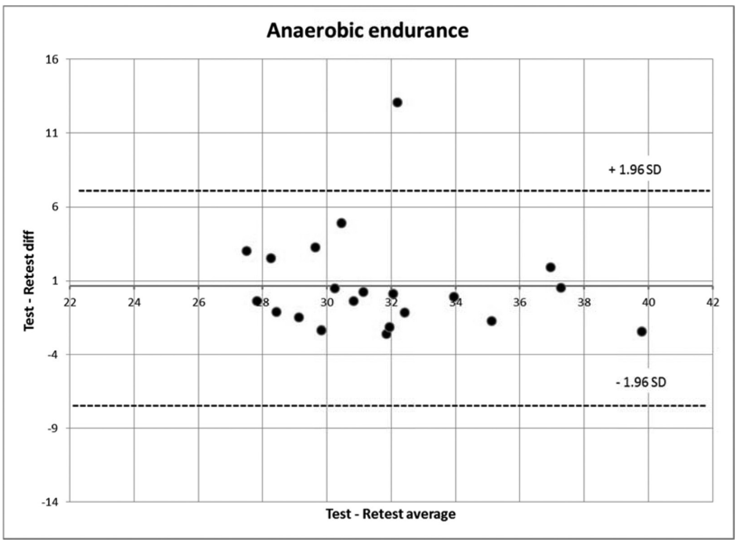

Figure 2 Bland Altman graphic of the test-retest average and differences for anaerobic endurance test

Slika 2. Bland-Altmanov grafički prikaz srednje vrijednosti razlika prvog i ponovljenog testa za anaerobnu izdržljivost

ANOVA identified significant differences between playing positions in body- height (F test = 7.54; $p < 0.05$), body- mass (F test = 14.76; $p < 0.05$), body-mass- index (F test = 7.6; $p < 0.05$), swimming-25m (F test = 3.46; $p < 0.05$) and swimming-400m (F test = 3.55; $p < 0.05$). For body- height, significant post-hoc differences are evidenced between: Points and Drivers, Points and Wings, Centres and Drivers, Centres and Wings (all at $p < 0.05$). For body mass, significant post-hoc differences were noted between all playing positions but Wings and Drivers. For swimming-25m significant post-hoc differences are found between Centres and Wings. Points dominated over Centres and Wings in swimming-400m (Table 2):

4. DISCUSSION / *Rasprava*

This study revealed several important findings. When observed in general, swimming capacities are differentially associated with various water polo playing positions. Specifically(i) the Wings are superior in sprint- swimming- and short-distance- swimming -capacity; but (ii) the Points are advanced in aerobic- endurance. Playing- positions do not significantly differ in their anaerobic- swimming- capacity. Finally, the results of anthropometric differences are as expected.

Swimming capacities are among the most important conditioning- capacities in water polo (Melchiorri et al., 2010). Studies have regularly confirmed differences between playing positions with regard to their achievement in sprint swimming and endurance swimming (Kondric et al., 2012). Yet, studies conducted so far have grouped Points and Centre-forwards in one group (i.e. Centres), while Drivers and Wings have been observed as „Outside players" (Kondric et al., 2012). To the best of our knowledge, no study has examined all four specific playing positions and compared swimming achievements regarding four swimming capacities (i.e. sprint- swimming, short-distance swimming, anaerobic- endurance and aerobic- endurance) as we did.

The superior sprint- swimming capacity of the Wings can be described by emphasising the two most important issues: (i) game- duties and consequently specific training; and (ii) the anthropometric characteristics of these players. In relation to (i), game- duties in water polo are relatively strictly defined (i.e. partly also because of the body build, please see the following text). Wing players are positioned laterally from the goal, and are therefore rarely in direct contact with the opponent. One of their most important game duties is to make a fast transition from defence to offense (Sekulic et al., 2015). Therefore, their overall game achievement directly relies on their sprint swimming capacity. However, in relation to (ii), their body build also contributes to their sprint capacity. They are not among the tallest players, but are clearly the lightest, which allows them to achieve a superior result on the water- polo- specific sprint swimming test we have observed in this study (i.e. starting from the water, with no push- off from the wall at the start).

In previous studies, Points have been regularly noted as being the „most athletic" of all water polo players (Kondric et al., 2012; Uljevic et al., 2014). This mainly relates to their game duties which keep those players far from the goal (during offence), but also in highly important game tasks during offence (i.e. Points are responsible for controlling the opponents' centre) (Uljevic et al., 2014). They also frequently have to swim at maximum after a contact game. As a result, Points develop their fitness capacities generally and not specifically. This is directly supported by our results. Namely, although Points are evidenced as being superior only for short-distance-swimming, measured by swimming over 100- metres (i.e. for this swimming capacity the statistical significance of differences between positions reached statistical significance), more detailed analysis actually revealed the Points as also being advanced, although not the best of all, in other swimming capacities (see Figure 1 for more details). This is particularly important knowing the anthropometric characteristics of these players. Together with the Centres, they are the tallest and have the highest body mass, which is consistent with previous studies (M. Lozovina, Durovic, & Katic, 2009; V. Lozovina & Pavicic, 2004). Swimming capacities are actually 'relative performances' (i.e. athletes perform swimming while having to 'overcome their own body dimensions). Therefore, the advanced body mass and stature of the Points, together with their exceptional swimming capacities, make for significant advancement in real-game performances. While their body mass and height allow them to perform efficiently in a contact game, their swimming capacities directly contribute to their agility, polyvalence and efficacy.

The playing positions observed herein did not differ in anaerobic-

Table 2 Analysis of the difference between playing-positions; Analysis of the variance – ANOVA (F test), with post-hoc Schafee test

Tablica 2. Analiza razlika između igračkih pozicija; analiza varijance – ANOVA (F test) s post-hoc Schafee testom

	Points (n = 19)	Centers (n = 16)	Wings (n = 25)	Drivers (n = 26)	ANOVA
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	F test
Body height (cm)	189.97±6.17^{D}	189.67±5.56^{D}	187.14±2.73	183.01±5.32^{P,C}	7.54*
Body mass (kg)	87.85±7.06^{C,W,D}	95.85±8.85^{P,W,D}	83.32±3.92^{P,C}	80.35±7.53^{P,C}	14.76*
Body mass index (kg/m^2)	24.37±1.9	26.62±1.9^{W}	23.79±0.92	24.01±2.21	7.6*
Triceps skinfold (mm)	11.14±3.08	11.79±4.08	10.63±3.12	12.04±3.52	0,32
Swimming-25m (s)	12.95±0.66	13.4±0.49	11.99±0.92^{C}	13.11±0.55	3.46*
Swimming-100m (s)	64.03±6.93	63.32±3.4	61.85±4.42	63.86±8.38	0,52
Swimming-400m (s)	271.09±48.65^{C,W}	301.78±14.78	298.51±23.82	283.31±45.93	3.55*
Anaerobic-endurance (s)	31.91±3.67	29.81±1.57	30.87±2.24	31.80±4.03	0,36

LEGEND: * denotes significant F test differences between groups; C denotes significant post-hoc differences between certain playing position and Centers; W denotes significant post-hoc differences between certain playing position and Wings; D denotes significant post-hoc differences between certain playing position and Drivers; P denotes significant post-hoc differences between certain playing position and Points endurance swimming capacity. This is additionally interesting given that (i) Centres actually achieved the best average score of all (29.81, 30.87, 31.80 and 31.91 seconds for Centres, Wings, Drivers and Points, respectively) and (ii) significant differences in body mass (i.e. Centres are tallest and heaviest of all with 190 cm and 96 kg on average) Such results are relatively novel, while to the best of knowledge no study has so far examined position- specific anaerobic endurance in youth male water polo players while differentiating four playing positions as we did. In explaining this, previous studies that defined physiological indices of the water polo game are particularly useful. In short, of all water polo players, Centres had the highest blood lactate values when observed in a real-game situation (Melchiorri et al., 2010). This is a natural consequence of their highly intensive workload since those players are practically constantly wrestling with the opponent's Point(s). Further, in modern water polo Centres are rarely excluded from the game (as is the case with Points) while most teams- only have one to two Centres. Therefore, it is not surprising that their lactate (i.e. anaerobic) capacities are advanced, although this is not followed by other swimming capacities.

Wings are the most advanced in the sprint- swimming capacity. While this is probably mostly associated with their body build (relatively light and not tall players), a particular part of their sprinting capacity is almost certainly associated with their specific game- duties (i.e. they are responsible for making a fast transition from offense to defence and are often involved in counterattacks).

This study confirmed previous observations that Points are the most 'athletic' of all water polo players. Points are found to be (statistically) superior to other players in short-distance swimming, but the remaining swimming capacities of these players are also among the best ones. Although heaviest and tallest, Centres are found to be highly effective in anaerobic endurance. This is almost certainly related to their game duties and their highly intensive workload.

Water polo coaches working with young athletes should be aware of these results and use the presented values as normative data to allow them to compare the values of their team- members with those presented herein. Namely, this study comprised athletes from one of the world's best national youth competitions, including team- members of the world- champions for the observed age- group.

5. CONCLUSION / *Zaključak*

The swimming capacity tests observed herein are found to be reliable testing procedures in the evaluation of swimming capacities of youth water polo players. Therefore, they should be used as indicators of different swimming capacities in this sport.

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