Coll. Antropol. **37** (2013) 4: 1261–1266
Original scientific paper

Sport-Specific and Anthropometric Factors of Quality in Junior Male Water Polo Players

Kemal Idrizović[1], Ognjen Uljević[2], Điivo Ban[3], Miodrag Spasić[2] and Nikola Rausavljević[2]

[1] University of Montenegro, Faculty of Sport and Physical Education, Podgorica, Montenegro
[2] University of Split, Faculty of Kinesiology, Split, Croatia
[3] University of Dubrovnik, Dubrovnik, Croatia

A B S T R A C T

There is evident lack of studies which examined anthropological determinants of success in water polo. The aim of this investigation was to study the physical fitness differences between two qualitative levels of junior water polo players (males; 16–18 years of age; 6+ year of experience in water polo). The sample (N=54) comprised of 13 members of the junior national-squad (5 centers and 8 perimeter players), and 41 team-athletes (11 centers and 30 perimeter players). The sample of variables included: four anthropometric measures (body height, body mass, BMI and body fat percentage), and five sport-specific fitness tests (20-meters-sprint-swimming, maximal dynamometric force in eggbeater kick, in-water vertical jump, drive-shoot-speed, and sport-swimming-endurance). Discriminant analysis and t-test revealed no significant differences between national-squad and team-players for center players. The national-squad perimeters were advanced over their team-level peers in most of the fitness capacities and body-height. The result highlights the necessity of the playing-position-specific approach in defining anthropological factors of success in team-sports.

***Key words**: differences, discriminant analysis, t-test, reliability, applicability*

Introduction

Although complex in tactical and technical background, water polo is a very specific sport with regard to fitness components necessary for effective competition[1]. Existing literature suggests that there are moderate demands on each of three energetic systems during a water polo game[2]. Research studies in the area of water polo have mainly focused on the physiological profile and load of game-play[3,4], anthropometric and fitness differences between playing positions[2,5–7], game intensity, sport-tactics and game-related statistics[8–10]. However, highly diverse game-duties outline the position-specific approach as the only reasonable method in determining the physiological background of the water polo. Consequently, it is reflected on fitness status of water polo players and necessity of the position-specific approach in training and sport-selection and orientation[4].

The anthropometric characteristics of the water polo players are also naturally related to players' game-tasks. Previous investigations regularly defined profound differences between playing positions in morphological anthropometric indices. Briefly, because of the constant tackle game which favors larger athletes, the centers (including points and center forward players) were found to be tallest and heaviest. At the same time, the perimeter players (driver and wings) are most responsible for fast transition from offense to defense (and vice-versa), and such tasks favors »lighter« athletes with advanced endurance capacities[1,7].

Similar to other team sports[11], in water polo the belief that the early identification of talents could lead to improved performance has cause that formal identification of talents begins in childhood and early adolescence. As a result, inclusion in male water polo starts at about 10 years of age. However, there is evident lack of studies which investigated fitness capacities of advanced-level junior water polo players. Moreover, to the best of our knowledge there is no recent study which compared physical fitness variables between different qualitative levels of junior water polo players. The data of such kind will be highly beneficial because of the two main reasons. First, it will assure proper orientation and selection of the potentially talented players. Second, the information

Received for publication November 13, 2013

about most important variables will allow water polo coaches and conditioning specialists to develop the training programmes aimed at improving the most important fitness capacities.

The main aim of this study was to define the anthropometric and fitness differences between two qualitative levels of junior water polo players. Apart from general differences (i.e. differences between national-squad and team-athletes), we have additionally investigated differences between two observed qualitative groups for two main playing positions (i.e. separately for centers and perimeter players).

Materials and Methods

Subjects

The subjects were junior male water polo players (N=54; 16 to 18 years of age). The total sample consisted of 16 center players (points and center forwards) and 38 perimeter players (wings and drivers). Study did not comprise goalkeepers. The total sample included 13 members of the Croatian Junior National Squad (five centers and eight perimeters), and 41 team-athletes (11 centers and 30 perimeters). Subjects were tested in the season of 2011–12, and at the moment of testing all had been active in water polo for 7–9 years.

Variables

Morphological – anthropometric variables in this study comprised: body height (BH), body mass (BM), body mass index (BMI), and the percentage of body fat (BF%). The BH and BM were assessed using standardized protocols by digital measuring instruments. The BMI was calculated as a ratio of BM (kg) and squared BH (in meters). Body fat percentage (BF%) was calculated on a basis of four skinfolds (biceps, triceps, subscapular and suprailiac) and calculated body density (BD)[12].

Sport-specific water polo fitness tests observed in this study were: swimming sprint on a 20 meters distance, in-water jump (thrust), drive shoot test, multilevel swimming endurance test, and a characteristic dynamometric semi-tethered force test. Swimming sprint test over a 20 meters distance (S20M) was tested upon a sound signal, similar to sprinting for ball possession at the start of a game (no push-start). In-water jump (WJUMP) or a one-arm vertical thrust was measured from a standard defensive position using a measuring scale and camcorder[13]. The semi-tethered dynamometric test (DYN) consisted of maximum intensity upright swimming using an eggbeater kick with a fast elastic line fixed to a special belt and dynamometric apparatus connected to personal computer[1]. Drive-shoot (DSHOOT) throwing velocity was using a velocity-detecting radar (Speedster Radar Gun (Bushnell, Overland Park, Kansas, USA). Multi-stage swimming test (MSST) was commenced to assess swimming aerobic endurance[14]. All testing protocols are explained in details elsewhere[15].

The subjects were tested on anthropometrics, WJUMP and DYN on the first testing day; DSHOOT and S20M on the second day; and the MSST on the third day. All of the fitness tests, excluding the MSST were done over three trials and the best result was retained as final achievement. The MSST was comprised throughout test-retest procedure with 5–6 days between test and retest trial for all participants.

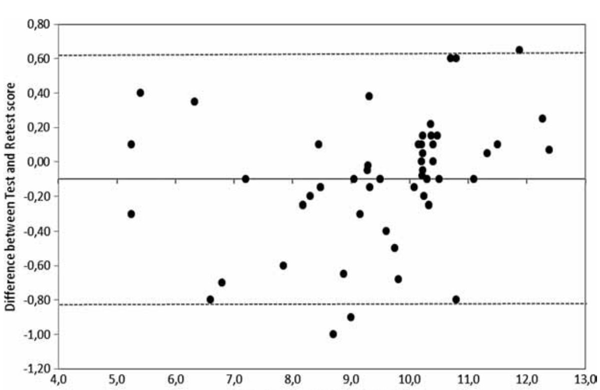

Fig. 1. Bland-Altman Plot of the test and retest scores of the multi-stage-swimming-test. The middle line represents the mean difference between the two trials. The two outside dashed lines represent the upper and lower limits of agreement.

Data analysis

All variables were found to be normally distributed by means of Kolmogorov Smirnov's test. Descriptive statistics calculations included means, minimum, maximum and standard deviation for all variables.

Reliability analysis included calculation of the average inter-item correlation (IIR) and coefficient of the variation (CV) for all multiple items tests. Test-retest correlation and Bland-Altman limits of agreement was calculated as measures of reliability for the MSST. Additionally, ANOVA for repeated measures was applied to determine possible systematic bias between testing trials (for multiple-trial tests) and between test and retest (for the MSST)[14,16].

Multivariate differences between the national-squad and team-athletes were calculated using the forward stepwise canonical discriminant analysis. Additionally, the t-test for independent samples was calculated to determine univariate differences between qualitative groups. Statsoft's Statistica ver. 10 was used for all calculations.

Results

The CV and IIR for all variables indicated appropriate reliability of the multiple-trial tests. The highest within subject reliability was found for DSHOOT and S20M, followed by WJUMP and DYN (CVs of 2%; 2%; 3%; 4% and 7%; respectively). The DSHOOT had the highest between-subject reliability (IIR=0.90), followed by WJUMP and DYN (IIR=0.89 for both tests), and S20M (IIR=0.83). The ANOVA found no systematic differences between testing trials.

The reliability of the MSST was high, with test-retest correlation of 0.96. According to Bland Altman plot, the test-retest mean difference was –0.10 (95% CI=0.1), with the limits of agreement ranging from 0.63 above to –0.83 below the difference (Figure 1).

Discriminant analysis between national-squad and team-athletes calculated for the total sample of subjects (not dividing according to playing position) found significant multivariate differences between two observed qualitative groups. Significant model included DSHOOT, BH and BFAT%. In general, national-squad athletes are taller and dominate in DSHOOT over their less successful peers. Discriminant analysis did not reach appropriate level of significance when calculated exclusively for center players. At the same time, the multivariate differences are significant when observed between national-squad and team-perimeter players, and national-squad perimeter players dominate in DYN and DSHOOT (Table 1).

Univariate differences follow the previously reported findings of the multivariate analyses. National squad athletes are generally taller and achieved better on DSHOOT. When compared between two observed qualitative levels, the centers do not differ significantly in any of the measured variables. In the meantime, the national-squad-perimeters demonstrated significantly greater dynamometric force, sprint-swimming ability, shooting capacity and are advanced in swimming endurance (Table 2).

TABLE 1
MULTIVARIATE DIFFERENCES BETWEEN TEAM-ATHLETES (TA) AND NATIONAL-SQUAD-ATHLETES (NS) – RESULTS OF THE FORWARD STEPWISE CANONICAL DISCRIMINATIVE ANALYSES

Total sample		Centers		Perimeters	
	Root 1		Root 1		Root 1
DSHOOT	–0.77	S20M	0.49	DYN	–0.89
BH	–0.69	DSHOOT	0.23	DSHOOT	–0.78
BFAT%	0.14	MSST	–0.29		
Can R	0.49		0.57		0.49
WL	0.75		0.66		0.75
p	0.01		0.17		0.01
C: TA	0.25		–0.45		0.28
C: NS	–0.83		0.98		–1.11

Can R – canonical coefficient of correlation; WL – Wilks Lambda; p – level of significance; C – position of the centroid; Root – structure of the significant discriminant root; BH – body height; BF% – percentage of body fat; S20M – swimming sprint on a 20 meters distance; DSHOOT – drive shoot test; MSST – multilevel swimming endurance test; DYN – dynamometric semi-tethered force test

Discussion

There are several important findings of this study. First, sport-specific-fitness-tests used in this investigation are found to be reliable with regard to within-subject, and between-subject reliability parameters. Second, tests are applicable in defining the differences between qualitative groups of junior water polo athletes. Third, position-specific approach in defining the fitness-specifics in water polo is found as appropriate.

Reliability

It is known that »in-water« tests are generally less reliable than »on-ground« ones. Briefly, due to the influence of uncontrollable factors like waves, difficulties in orientation etc., it is hard to achieve stability of perfor-

TABLE 2
UNIVARIATE DIFFERENCES BETWEEN TEAM-ATHLETES (TA) AND NATIONAL-SQUAD-ATHLETES (NS) – RESULTS OF THE T-TEST FOR INDEPENDENT SAMPLES

	Total sample		Centers		Perimeters	
	TA	NS	TA	NS	TA	NS
	$\bar{X}$±SD	$\bar{X}$±SD	$\bar{X}$±SD	$\bar{X}$±SD	$\bar{X}$±SD	$\bar{X}$±SD
BH (cm)	184.08±6.7	188.32±5.92*	188.42±6.08	189.84±4.76	182.49±6.28	187.36±6.66*
BM (kg)	82.34±10.15	85.41±8.97	89.89±9.55	85.94±7.74	79.57±9.0	85.08±10.16
BMI (kg/m^2)	24.24±2.22	24.03±1.63	25.27±1.76	23.83±1.68	23.87±2.28	24.15±1.7
BFAT% (%)	19.49±2.54	19.33±3.67	20.14±2.67	18.55±3.33	19.25±2.49	19.82±4.01
MSST (min)	9.17±1.72	10.14±1.45	9.70±1.53	9.09±1.36	8.98±1.77	10.80±1.13*
DYN (kg)	30.39±5.3	32.67±6.88	34.46±4.77	31.42±9.2	28.89±4.71	33.45±5.56*
S20M (s)	11.43±0.59	11.23±0.53	11.27±0.5	11.61±0.44	11.49±0.62	10.99±0.45*
DSHOOT (km/h)	66.15±5.19	70.15±4.72*	67.45±4.74	69.01±4.9	65.67±5.34	70.88±4.79*
WJUMP (cm)	137.35±11.95	140.06±16.81	144.24±10.29	141.62±10.7	134.64±11.60	140.04±12.46

BH – body height; BM – body mass; BMI – body mass index; BF% – percentage of body fat; S20M – swimming sprint on a 20 meters distance; WJUMP – in-water jump (thrust); DSHOOT – drive shoot test; MSST – multilevel swimming endurance test; DYN – dynamometric semi-tethered force test; * denotes significant t-test differences between qualitative levels mance across trials when tests are done in-water[17]. Therefore it is important to note that the tests of the in-water jumping (WJUMP) and sprinting (S20M) are of minimally lower reliability than similar on-ground jumping and sprinting tests[18]. At the same time, there is no evident difference in reliability parameters of DSHOOT in comparison to the similar tests performed on-ground[19].

The high reliability of the MSST was somewhat expected since previous studies approved the consistency of this test[14]. However, it is important to note that this is one of the first studies which applied this test in water polo. Therefore, the test should be judged as applicable measuring tool in defining the aerobic endurance in water polo juniors.

Anthropometrics and body composition in junior water polo athletes

It is known that body size can contribute to achievement in water polo[2,20]. This is logical, knowing that the pronounced body height and longer arms allow the player to reach and control the ball and the opponent more efficiently. However, our results show that importance of the BH is characteristic only among perimeter players of junior age. In short, while perimeter players of the higher-quality-rank (i.e. national-squad) are significantly taller than their team-level peers; there is no significant difference in the BH between qualitatively different centers. However, the BH is not included in successful discriminant model for perimeters, and this is almost certainly influenced by redundancy of BH and those measures included in the significant discriminant model (i.e. DSHOOT and DYN). Mainly, additional correlation analysis showed that BH is highly correlated to DSHOOT (r=0.79). Therefore, analysis' calculation retained the DSHOOT as more valid measure for the purpose of multivariate group-differentiation[21].

Previous studies reported BW as a important factor of success in water polo[1]. But, this anthropometric measure was not found as a factor which significantly discriminate qualitative groups. Most likely, majority of the junior athletes we have investigated did not finalize their growth and development (especially with regard to muscle mass), and therefore there is a certain probability that the differences in BW between two observed qualitative groups did not reach the final magnitude.

Although most of the sport-studies discuss body fat measures as an indicator of ballast (i.e. unnecessary) mass, and therefore report this anthropometric measure as negatively related to sport-achievement[22], such findings are not strongly supported in water sports (i.e. water polo, synchronized swimming) so far. Briefly, it is discussed that body fat in those sports should be observed as an factor of positive influence on buoyancy, and therefore factor of positive influence on some characteristic movement-templates in water-sports[14,17]. It must be stressed that this does not mean that BF% in water polo should be increased uncritically, but rather that the 18–20 for BF% (i.e. BMI of 23–25 kgm^{-2}) should be observed as a certain »target value« for this group of subjects (junior males).

Sport-specific motor fitness in junior water polo athletes

The test of the in-water vertical jumping used herein is originally presented when Platanou reported data on senior athletes[13]. Interestingly, results of our juniors do not differ from results of senior athletes presented in that study 7–8 years ago. Since there is no evident discrepancy between BH measures between two samples (about 186 cm both for our juniors and seniors), it is probable that the physical fitness status of the water polo players is generally improved from 2005 onward.

Of all studied variables DSHOOT is found to be most important with regard to players' quality. Mainly, it seems that this performance measure is the most significant discriminator of more and less successful juniors. Multivaritely it is found for total sample and perimeters, and univariately – for total sample, centers and perimeters. Knowing the importance of the shooting performance in water polo this finding is expected [23]. Among perimeter players DYN achievement is found to be significant also. However, it must be emphasized that for perimeters this performance is almost exclusively related to offensive game-duties since during the offence those players are positioned relatively far from the goal and are rarely in direct contact with the opponent[7]. Univariate dominancy of the national-squad perimeters in aerobic endurance (MSST) and sprint-swimming-capacity (S20M) are also logical knowing the game duties of those players. Namely, perimeter players are responsible for quick transition between offence and defense, and sprint swimming capacity is a factor clearly associated to their achievement in those tactical tasks[24]. During the game, perimeters are not as frequently substituted as centers[25]. Therefore, their fitness quality is directly related to the aerobic endurance.

While National-squad-perimeters demonstrated greater fitness capacity than team-level-perimeter-players in most of the observed tests (i.e. significant differences are found in four of five fitness variables); the national-squad centers performed significantly better form team-level-centers only in DSHOOT. The reason for such dissimilarities in findings (i.e. fitness status is found to be important factor of success for perimeters, but not so important for centers) could be explained throughout two probable reasons. First, it is possible that center players quality in junior age is not so profoundly defined by fitness status but rather by »game intelligence«, which was previously suggested[26]. Second, it is also possible that fewer »n« of centers and therefore fewer degrees of freedom in statistical calculations did not allow definition of the significant differences for this particular playing position. Regardless of the explanation, the position-specific approach in defining the fitness differences seems to be appropriate methodology for the purpose of the explanation of those variables important in male junior water polo players. Mainly, if fitness differences would be discussed on a basis of »overall-sample-differences« (i.e. differences found between team-athletes and national-

-squad not dividing them according to playing position) evident misinterpretations could appear.

Limitations

The main limitation of this study is related to the unequal number of subjects in each of the studied groups (i.e. playing positions). However, this is the natural consequence of the water polo game, and number of players on each playing position. However, this difference is emphasized within the discussion section as one of the possible reasons for obtained results. Also, the study comprised only of sport-specific-field tests and therefore some potentially important laboratory-based measuring protocols were not included. But, our main intention was to use »ecologically-valid« testing protocols (test protocols applicable in »real-world«) and therefore we focused only on those variables which are easily obtainable in diverse sport-communities. As a result, although aware that the study is not the final word on a topic, we believe that our findings contribute to the understanding of success in junior water polo players and can be implemented for improvement of training process.

Conclusion

To the best of our knowledge this is the first study which investigated fitness factors related to quality of junior water polo players with regard to playing-positions. The findings of this study allow us to draw the following conclusions.

There are certain evidences that physical fitness status of the water polo players improved considerably during the last decade.

Shooting performance and dynamometric-upright swimming performance are found to be most important factors of success in perimeter players. In addition, swimming-aerobic-endurance and sprint-swimming-capacity are also found to be important.

Anthropometric indices are not evidenced as factors which contribute to quality of water polo juniors. However, it must me stressed that sample in this study comprised of players from one of the best water polo nations in the world and that differences between team-athletes and National-squad-athletes are probably not so profound.

Differences that were found between qualitative levels for total sample of subjects are not comparable to those differences which were found when playing positions were studied separately. Therefore, the position-specific approach in defining factor of success in team sports is clearly reinforced.

REFERENCES

1. KONDRIC M, ULJEVIC O, GABRILO G, KONTIC D, SEKULIC D, J Hum Kinet, 32 (2012) 157. DOI: 10.2478/v10078-012-0032-6. — 2. TAN FH, POLGLAZE T, DAWSON B, COX G, J Strength Cond Res, 23 (2009) 1530. DOI: 10.1519/JSC.0b013e3181a39261. — 3. MELCHIORRI G, CASTAGNA C, SORGE R, BONIFAZI M, J Strength Cond Res, 24 (2010) 2647. DOI: 10.1519/JSC.0b013e3181e3486b. — 4. MELCHIORRI G, PADUA E, SARDELLA F, MANZI V, TANCREDI V, BONIFAZI M, J Sports Med Phys Fitness, 50 (2010) 19. — 5. FERRAGUT C, ABRALDES JA, VILA H, RODRIGUEZ N, ARGUDO FM, FERNANDES RJ, J Hum Kinet, 27 (2011) 31. — 6. VILA H, FERRAGUT C, ABRALDES JA, RODRIGUEZ N, ARGUDO FM, Rev Int Med Cienc Ac, 10 (2010) 652. — 7. LOZOVINA M, DUROVIC N, KATIC R, Coll Antropol, 33 (2009) 781. — 8. PLATANOU T, J Hum Movement Stud, 46 (2004) 205. — 9. LUPO C, CONDELLO G, TESSITORE A, J Sport Sci Med, 11 (2012) 516. — 10. ESCALANTE Y, SAAVEDRA JM, TELLA V, MANSILLA M, GARCIA-HERMOSO A, DOMINGUEZ AM, J Sport Sci Med, 11 (2012) 475. — 11. SRHOJ V, ROGULJ N, PAPIC V, FORETIC N, CAVALA M, Coll Antropol, 36 (2012) 967. — 12. JELICIC M, SEKULIC D, MARINOVIC M, Coll Antropol, 26 (2002) S69. — 13. PLATANOU T, J Sports Med Phys Fitness, 45 (2005) 26. — 14. SAJBER D, PERIC M, SPASIC M, ZENIC N, SEKULIC D, Int J Perf Anal Spor, 13 (2013) 23. — 15. ULJEVIC O, ESCO MR, SEKULIC D, J Strength Cond Res, 2013 Publish Ahead of Print, DOI: 10.1519/JSC.0000000000000308. — 16. SATTLER T, SEKULIC D, HADZIC V, ULJEVIC O, DERVISEVIC E, J Strength Cond Res, 26 (2012) 1532. DOI: 10.1519/JSC.0b013e318234e838. — 17. PERIC M, ZENIC N, MANDIC GF, SEKULIC D, SAJBER D, J Hum Kinet, 32 (2012) 135. DOI: 10.2478/v10078-012-0030-8. — 18. SEKULIC D, SPASIC M, MIRKOV D, CAVAR M, SATTLER T, J Strength Cond Res, 27 (2013) 802. DOI: 10.1519/JSC.0b013e31825c2cb0. — 19. HARASIN D, DIZDAR D, MARKOVIC G, J Hum Movement Stud, 51 (2006) 63. — 20. TSEKOURAS YE, KAVOURAS SA, CAMPAGNA A, KOTSIS YP, SYNTOSI SS, PAPAZOGLOU K, SIDOSSIS LS, Eur J Appl Physiol, 95 (2005) 35. DOI: 10.1007/s00421-005-1388-2. — 21. HUCK SW, Reading Statistics and Research. (Pearson College Division, 2011). — 22. JUKIC J, KATIC R, BLAZEVIC S, Coll Antropol, 36 (2012) 1247. — 23. ALCARAZ PE, ABRALDES JA, FERRAGUT C, VILA H, RODRIGUEZ N, ARGUDO FM, J Strength Cond Res, 26 (2012) 1852. DOI: 10.1519/JSC.0b013e318237ea4f. — 24. D'AURIA S, GABBETT T, Int J Sports Physiol Perform, 3 (2008) 305. — 25. HRASTE M, DIZDAR D, TRNINIC V, Coll Antropol, 34 (2010) 473. — 26. FALK B, LIDOR R, LANDER Y, LANG B, J Sports Sci, 22 (2004) 347. DOI: 10.1080/02640410310001641566.

N. Rausavljević

University of Split, Faculty of Kinesiology, Teslina 6, 21000 Split, Croatia
e-mail: raus@kifst.hr

SPORTSKO-SPECIFIČNE I ANTROPOMETRIJSKE ZNAČAJKE KVALITETE JUNIORSKIH VATERPOLO IGRAČA

S A Ž E T A K

Evidentan je nedostatak znanstvenih radova koji proučavaju antropološke odrednice kvalitete igrača u vaterpolu. Cilj ovog istraživanja je bio utvrditi razlike u motoričkim sposobnostima i antropometrijskim osobinama između dvije grupe juniora vaterpolista različite igračke kvalitete (vaterpolisti starosti 16–18 godina; 6+ godina trenažnog staža). Uzorak ispitanika (N=54) se sastojao od 13 članova juniorske vaterpolo reprezentacije (5 centara i 8 vanjskih igrača) i igrači koji su u istoj sezoni nastupali za svoje klubove (N=41; 11 centara i 30 vanjskih igrača). Uzorak varijabli se sastojao od: četiri antropometrijske mjere (tjelesna visina, tjelesna težina, indeks tjelesne mase i postotak potkožnog masnog tkiva), i pet sport-specifičnih testova (brzina vaterpolo plivanja na 20 metara, maksimalna dinamometrijska sila vaterpolskom »biciklom«, vertikalni iskok iz vode, brzina leta lopte kod vaterpolo udarca i aerobna izdržljivost u plivanju). Diskriminativna analiza i t-test su pokazali da na poziciji centra između reprezentativaca i klupskih igrača ne postoji statistički značajna razlika u mjerenim varijablama. Međutim, kada se analiziraju vanjski igrači, reprezentativci su viši i imaju značajno bolje rezultate u većini motoričkih sposobnosti od klupskih igrača koji igraju na istoj poziciji. Razlika je najevidentnija u brzini leta lopte i postignutoj dinamometrijskoj sili u vaterpolskom »biciklu«. Rezultati ovog istraživanja ukazuju na potrebu da se antropološke odrednice uspješnosti u timskim sportovima utvrđuju po pojedinim igračkim pozicijama.