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Anthropometric Characteristics and Specific Functional Swimming Capacities in Youth U12 Water Polo Players

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Abstract

Introduction: Water polo is a physically high-demanding team sport, therefore players' physical abilities and anthropometric characteristics are important factors to achieve a good level of quality in technical-tactical actions. The aim of this study was to determine the association of the chronological age with the anthropometric characteristics and specific functional swimming capacities in youth U12 male water polo players. Methods: There were 170 youth U12 water polo players who attended the Croatian Water Polo Federation training camps included in this cross-sectional study. Measurements included anthropometric characteristics and specific functional swimming capacities. Results: Players were divided according to their chronological age: Q1 (January-March) – 59 players (34.7%), Q2 (April-June) – 35 players (20.6%), Q3 (July-September) – 46 players (27.1%) and Q4 (October-December) – 30 players (17.6%). Older players born in Q1 presented higher values of body height and weight than their younger peers born in Q4 (Q1 165.96±7.88 cm vs. Q4 159.46±5.44 cm, P=0.001; Q1 60.14±13.99 kg vs. Q4 51.35±7.09 kg, P=0.023), while there were no statistically significant differences in specific functional swimming tests between different age groups. Discussion: Contrary to what was hypothesized, older water polo players presented only better anthropometric characteristics than their younger peers, probably due to the biological maturity influence on functional skills, as well as small range of chronological age differences. Conclusion: Such data might provide an understanding of the general and specific water polo player's development process, which should be considered by coaches of youth players to improve their skills as a result of developing better training programs.

Keywords: *water polo, chronological age, development, swimming, performance*

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Introduction

Water polo is a physically high-demanding team sport characterized by exchange of activities with different energy load while players constantly move through the field in the water. In such environment players use different swimming intensity, receiving, dribbling and passing the ball, as well as shooting accurately on the goal. Additionally, they use different techniques to accomplish many complex technical-tactical actions while wrestling with the opponents (Smith, 1998, Botonis et al., 2015, Sekulić et al., 2016). Several authors indicated physical abilities and anthropometric characteristics as important factors to achieve a good level of quality in technical-tactical actions, both for young and adult water polo players, especially considering constant physical contact during the game (Kondrič et al., 2012, Uljević et al., 2013, Sekulić et al., 2016, Gardasevic et al., 2017, Kontić et al., 2017, Melchiorri et al., 2017, Viero et al., 2020). Greater body height and longer extremities also allow players to reach for the ball more easily, to shoot and to perform blocks more efficiently (Idrizović et al., 2014, Dimitrić et al., 2022). It is well known that water polo players' anthropometric characteristics are highly related with high performance levels, influencing intensive offensive and defensive actions in each playing position (Ferragut et al., 2011, Kondrič et al., 2012). Along with body size, swimming capacity is also related to the general performance level of youth water polo players in a game (Kontić et al., 2017, Melchiorri et al., 2017, Vasiljevic et al., 2021). Since in recent years, water polo as a game has become more dynamic, the transition from offense to defense is faster increasing the frequency of situational parameters, player contacts are stronger and there are more frequent transitions from horizontal to vertical body position (Kovačević, 2012, Uljević et al., 2021). Consequently, to reach higher level of general performance in the game, youth water polo players need to develop high swimming capacity (Kontić et al., 2017, Melchiorri et al., 2017).

Other than anthropometric characteristics and physical abilities, the complex process of growth and maturation must be considered for young athletes to ensure suitable training and competition routines. The players' initial development processes require deeper theoretical and practical knowledge, which might help to improve the training process and early identification of talented players (Escalante et al., 2013, Chirico et al., 2021). Chronological age is the traditional strategy to categorize young athletes appropriately for their level of development (Lloyd et al., 2014, Giudicelli et al., 2021). Growth is the process of increasing body size in whole or in parts, while biological maturation refers to physiological and cognitive development towards adulthood. Maturational events have an established order in which they happen but the moment when they occur and their duration have vast variability between individuals, even at the same age, affecting the physical, technical and psychological performance of young athletes (Malina et al., 2004, Lloyd et al., 2014, Giudicelli et al., 2021). In sports where strength, power and speed are extremely important and physical contact is inevitable, more mature individuals who are usually taller and heavier show better results in motor, physical and functional evaluations compared with their peers in chronological age (Ford et al., 2011, Till et al., 2014, Luna-Villouta et al., 2021). Such differences usually disappear when late-maturing athletes reach higher levels of maturation at the end of adolescence or in the beginning of adulthood (Malina et al., 2004, Lloyd et al., 2014).

Considering the importance of the chronological age and maturity, as well as functional development of youth water polo players, the aim of this study was to determine the association of the chronological age (see Methods section for details) with the anthropometric characteristics and specific functional swimming capacities in youth U12 male water polo players.

Methods

Subjects

This cross-sectional study included 170 youth water polo field players (goalkeepers were excluded due to the small number and different specific functional swimming tests conducted) who attended the Croatian Water Polo Federation (CWPF) training camp from the season 2015/2016 until 2020/2021 at the age of 12 (U12), representing the initial selection. The CWPF training camps are selective, developmental programs on-going for past 10 years, organized by the head coach-leader of the CWPF training camps, supported by 8-12 licensed water polo coaches who participated in all training activities assuring professional supervision of it. The training camps lasted for four days, with seven specific technical-tactical training sessions adjusted to the development level of youth players. All players who attended training camps had over two years of competitive practice. They trained regularly with their own teams with an average of 5 training sessions per week, lasting approximately for two hours and they participated in the highest league for their age group, playing between 20 and 30 games each season. The players were divided according to their chronological age in four groups: Q1 – those who were born in the first quarter of the year (January-March), Q2 – those who were born in the second quarter of the year (April-June), Q3 – those who were born in the third quarter of the year (July-September) and Q4 – those who were born in the fourth quarter of the year (October-December), respectively. Written informed consent was obtained from parents / legal guardians, with the study being approved by the Ethical Committee of the University of Split School of Medicine, Split, Croatia (N.: 2181-198-03-04-19-0053).

Measurements and variables

In this study a battery of tests performed included anthropometric characteristics' measurements and specific functional swimming tests. Anthropometric variables included body height and weight which were measured using a stadiometer and a digital scale, respectively, while the subjects wore only swimming trunks. Body Mass Index (BMI) was calculated as body weight (kg) divided by height squared (m^2). Water polo players' functional capacities were assessed by specific functional swimming tests including 25 m front crawl, 50 m front crawl, 100 m front crawl, 400 m front crawl, 25 m ball dribbling, 25 m eggbeater kicking, 25 m front crawl legs kicking. The players were timed with hand-held digital stopwatch (Longines, Saint-Imier, Switzerland) performing various distances and styles in 25-m swimming pool, starting at the sound signal from the water. They were allowed to push-off the wall at the start and after the turn, but a flip turn was not allowed. They were instructed to swim at maximum speed for each test. For 25 m dribbling the ball players were instructed to dribble the ball from wall to wall of the swimming pool, without throwing it and to touch the wall with one hand. Eggbeater kick is a cyclical movement and it consists of alternating the circular, asymmetric, continuous movements of the legs, an alternat-

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ing circumduction of the hips accompanied by knee flexion/extension and medial to lateral rotation, producing an upward force and maintaining players afloat in a vertical position. Upper limbs are kept free, giving the opportunity to do technical movements with or without the ball (passing, throwing, tackling an opponent, wrestling, catching or intercepting passes, and blocking shots on goal) remaining vertical or moving in any direction while in a vertical position (Uljevic et al., 2013). For testing 25 m eggbeater kicking players were instructed to swim in semi-horizontal body position with legs only, using eggbeater kick, while hands were neutralized with the ball, and head over the water surface.

Statistical analysis

Data analyses were performed using statistical software MedCalc for Windows (Microsoft Corp., Redmond, WA, USA), version 19.4. (MedCalc Software, Ostend, Belgium). Continuous data were presented as mean±standard deviation or whole number and percentage for categorical variables. The Kolmogorov-Smirnov test was used to assess normality of data distribution. Although data were not normally distributed according to the Kolmogorov-Smirnov test, it showed favorable distribution on Q-Q plots. Differences in anthropometric characteristics and specific functional swimming capacities of youth U12 water polo players according to the chronological age were tested using Kruskal-Wallis test with the post-hoc analysis. Additionally, Pearson's correlation coefficient analysis was performed to determine a relationship between chronological age, anthropometric characteristics and results of specific functional swimming tests, while multiple regression analysis was performed to determine the association between selected independent variables (anthropometric characteristics, specific swimming tests) with the chronological age of water polo players (dependent variable). The statistical significance was set at $P<0.05$.

Results

There were 170 youth U12 water polo players, divided according to their chronological age / the quarter of the year they were born in as follows: Q1 (January-March) – 59 players (34.7%), Q2 (April-June) – 35 players (20.6%), Q3 (July-September) – 46 players (27.1%) and Q4 (October-December) – 30 players (17.6%). Data about their baseline anthropometric characteristics and specific functional swimming capacities are presented in Table 1.

Table 1. Baseline characteristics of youth U12 water polo players

Chronological age (N=170)	N (%)
Age categories (quarter)	
Q1	59 (34.7)
Q2	35 (20.6)
Q3	46 (27.1)
Q4	30 (17.6)
Anthropometric characteristics (N=170)	Mean ± SD
Body height (cm)	163.27±7.51
Body mass (kg)	56.69±12.31
Body mass index (kg/m^2)	21.13±3.47
Specific functional swimming capacities	Mean ± SD
Front crawl, 25 m (s) N=143	16.45±1.14
Front crawl, 50 m (s) N=169	36.44±5.74
Front crawl, 100 m (s) N=140	79.91±5.29
Front crawl, 400 m (s) N=169	373.59±35.95
Front crawl leg kicks, 25 m (s) N=108	27.99±8.28
Eggbeater, 25 m (s) N=108	28.38±5.64
Dribbling, 25 m (s) N=170	17.73±1.48

Data are presented as mean±standard deviation or as whole numbers and percentage. Q1 – players born in the first quarter of the yeat (January-March); Q2 – players born in the second quarter of the year (April-June); Q3 – players born in the third quarter of the year (July-September); Q4 – players born in the fourth quarter of the year (October-December). Eggbeater - swimming in semi-horizontal body position with legs only, using eggbeater kick (cyclical movement consisting of alternating the circular and continuous movements of the legs, an alternating circumduction of the hips accompanied by knee flexion/extension and medial to lateral rotation, producing an upward force and maintaining players afloat in a vertical position), while hands were neutralized with the ball, and head over the water surface. Dribbling - dribbling the ball from wall to wall of the swimming pool, without throwing it and touching the wall with one hand.

Older players born in Q1 presented higher values of body height and weight than their younger peers born in Q4 (Q1 165.96±7.88 cm vs. Q4 159.46±5.44 cm, P=0.001; Q1 60.14±13.99 kg vs. Q4 51.35±7.09 kg, P=0.023), while there were no statistically significant differences in specific functional swimming tests between different age groups (Table 2).

In Table 3, the Pearson's correlation coefficient between chronological age, anthropometric characteristics and specific functional swimming capacities of youth U12 water polo players can be seen.

There were no strong correlations between tested variables. Although P was significant for the correlation between the age categories and body height (r=-0-333, P=0.001) and

Table 2. Comparison of anthropometric characteristics and specific functional swimming capacities of youth U12 water polo players according to the chronological age

Chronological age	Q1 N=59	Q2 N=35	Q3 N=46	Q4 N=30	P
Anthropometric characteristics (N=170)					
Body height (cm)	165.96±7.88[c,d]	164.21±7.28[d]	161.47±7.04[a]	159.46±5.44[a,b]	0.001
Body mass (kg)	60.14±13.99[d]	57.13±13.53[a,d,e]	55.33±10.37	51.35±7.09[a]	0.027
Body mass index (kg/m^2)	21.61±3.53	21.12±4.23	21.13±3.14	20.21±2.74	0.299
Specific functional swimming tests					
Front crawl, 25 m (s) N=143	16.30±1.12	16.51±0.99	16.50±1.12	16.63±1.37	0.626
Front crawl, 50 m (s) N=169	36.31±2.61	36.59±2.37	36.51±1.68	36.42±2.96	0.643
Front crawl, 100 m (s) N=140	80.17±5.64	79.94±5.27	79.99±4.23	79.21±6.32	0.880
Front crawl, 400 m (s) N=169	374.13±30.59	381.18±59.25	370.65±18.79	368.20±29.51	0.778
Front crawl leg kicking, 25 m (s) N=108	27.63±2.98	27.50±2.26	28.58±2.60	28.37±3.50	0.404
Eggbeater kicking, 25 m (s) N=108	28.57±2.50	28.49±1.98	28.30±2.10	28.02±2.90	0.941
Dribbling, 25 m (s) N=170	17.55±1.53	17.97±1.45	17.60±1.40	17.98±1.55	0.474

Data are presented as mean±standard deviation. *Kruskal-Wallis test with the post-hoc analysis; P < 0.05. [a] comparison with Q1 (P < 0.05). [b] comparison with Q2 (P < 0.05). [c] comparison with Q3 (P < 0.05). [d] comparison with Q4 (P < 0.05). Eggbeater - swimming in semi-horizontal body position with legs only, using eggbeater kick (cyclical movement consisting of alternating the circular and continuous movements of the legs, an alternating circumduction of the hips accompanied by knee flexion/extension and medial to lateral rotation, producing an upward force and maintaining players afloat in a vertical position), while hands were neutralized with the ball, and head over the water surface. Dribbling - dribbling the ball from wall to wall of the swimming pool, without throwing it and touching the wall with one hand.

body weight (r=-0.254, P=0.002), as well as between body height and certain specific functional swimming tests (25 m crawl r=-0.388, P<0.001; 50 m crawl r=-0.323, P=0.001; 100 m crawl r=-0.226, P=0.016; 25 m dribbling r=-0.356, P=0.001), correlation coefficient r showed weak or low correlation (Table 3).

Table 3. Pearson's correlation coefficient between chronological age, anthropometric characteristics and specific functional swimming capacities in youth U12 water polo players

	Body height (cm)		Body weight (kg)		BMI (kg/m^2)		Age (Q)	
	r	P	r	P	r	P	r	P
Age (Q)	-0.333	<0.001	-0.254	0.00	-0.131	0.119		
Front crawl, 25 m (s)	-0.388	<0.001	-0.107	0.203	0.078	0.353	0.102	0.224
Front crawl, 50 m (s)	-0.323	<0.001	-0.047	0.578	0.117	0.169	0.022	0.781
Front crawl, 100 m (s)	-0.226	0.016	0.081	0.397	0.218	0.021	-0.053	0.567
Front crawl, 400 m (s)	-0.113	0.184	0.011	0.897	0.070	0.406	-0.073	0.349
Dribbling, 25 m (s)	-0.356	<0.001	-0.013	0.122	0.036	0.674	0.070	0.362
Front crawl leg kicking, 25 m (s)	-0.139	0.152	0.055	0.575	0.149	0.122	0.130	0.179
Eggbeater kicking, 25 m (s)	-0.182	0.060	0.099	0.306	0.235	0.015	-0.084	0.385

*Significant correlation between variables, P < 0.05. BMI – body mass index; Q – quarter of the year players were born in. Eggbeater - swimming in semi-horizontal body position with legs only, using eggbeater kick (cyclical movement consisting of alternating the circular and continuous movements of the legs, an alternating circumduction of the hips accompanied by knee flexion/extension and medial to lateral rotation, producing an upward force and maintaining players afloat in a vertical position), while hands were neutralized with the ball, and head over the water surface. Dribbling - dribbling the ball from wall to wall of the swimming pool, without throwing it and touching the wall with one hand.

The statistical significance maybe was reached due to the large sample size (more than 100 subjects), and it has little practical importance (Taylor, 1990). Multiple regression analysis did not show any predictive value of chronological age as a dependent variable on anthropometric characteristics and specific functional swimming capacities (independent variables) in youth U12 water polo players.

The association between age-group water polo players' specific motor / swimming abilities and their anthropometric indices are provided in Table 4, showing no predicting value of

Table 4. Multiple regression analysis showing the predictive status of chronological age for the specific swimming abilities and anthropometric indices in youth U12 water polo players (N=170)

	β coefficient	SE	P*
Front crawl, 25 m (s)	0.103	0.179	0.564
Front crawl, 50 m (s)	-0.002	0.097	0.980
Front crawl, 100 m (s)	-0.313	0.037	0.530

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Table 4. Multiple regression analysis showing the predictive status of chronological age for the specific swimming abilities and anthropometric indices in youth U12 water polo players (N=170)

	β coefficient	SE	P*
Front crawl, 400 m (s)	-0.023	0.003	0.554
Dribbling, 25 m (s)	-0.007	0.109	0.951
Body height (cm)	-0.267	0.085	0.247
Body weight (kg)	-0.132	0.113	0.595
Body mass index (kg/m^2)	0.352	0.111	0.263
Least squares multiple regression			
Coefficient of determination R^2	0.256		
R^2-adjusted	0.213		
Multiple correlation coefficient	0.391		
Residual standard deviation	1.089		

the chronological age for the specific swimming abilities and anthropometric indices in youth U12 water polo players.

Discussion

With regard to the study aims, there are three most important findings. First, older youth players' born in Q1 chronological age category had significantly higher values of the body height and weight than their younger peers. Second, there were no significant differences between players in different chronological age categories in their specific functional swimming capacities, although we have hypothesized differently. Third, chronological age showed low correlation with the body height and weight, while there were no correlations between chronological age and specific functional swimming capacities. Other than moderate correlations between body height and 25 m front crawl and 25 m dribbling the ball, other specific functional swimming test showed low or no correlations with anthropometric variables.

Many previous studies showed tested swimming capacities as valid predictors of players' achievements, specifically between qualitatively different groups of players (for example national team players vs. lower performance level) (Falk et al., 2004, Uljević et al., 2021, Dimitrič et al., 2022, Kovačević et al., 2022). In this study the results did not discriminate older players over their younger peers in any conducted functional tests, but one should consider their chronological age as prepubescent, therefore differences between them were not prominent yet. We can only speculate that in older age of the puberty and intensive physical maturation differences in anthropometric characteristics and specific functional swimming capacities between older and younger players might be more distinguished. Still, one should be precautious in initial selection of youth water polo players based on showed results because besides functional and motor skills which are desirable to be well developed, many other skills such as general and specific endurance, agility, accuracy, coordination, reaction time, speed, cognitive skills, anticipation and decision-making time, game intelligence etc. contribute to the development of an elite water polo player. Youth water polo players with dominant anthropometric characteristics and well-developed specific functional swimming capacities have good predispositions to develop other important aspects of technical-tactical and situational demands of water polo game in order to become a successful elite water polo player, although in tested age group they had not yet reached the highest levels of motor skills and abilities on which decision-making abilities are based (Malina et al., 2004).

The knowledge of youth specific functional swimming capacities and their chronological, as well as biological development in water polo, using a multivariate approach might improve developmental program processes in youth water polo and might assist in role assignments between different playing positions in water polo teams. Such approach might also help in selection of appropriate game strategy and tactics, according to the capabilities of the selected players. Contrary to what was hypothesized in this study, older water polo players presented only better anthropometric characteristics, while their specific functional swimming capacities were similar to their younger peers, probably due to the biological maturity influence on functional skills, as well as small range of chronological age differences (Lopez-Plaza et al., 2021). Considering the observed anthropometric differences showed in the current study, an individualized training programs based on growth and development of young players is highly suggested.

Even if the current study included a multivariate approach to youth water polo performance, it has the limitation of presenting a different number of players per each age category, as well as small chronological age differences between groups, the players involved all belonged to the same age group, resulting with small or no differences in measured variables. Longitudinal studies on different age groups are therefore highly suggested for further analysis.

Conclusion

Data from the current study contribute to the specific knowledge about youth water polo players' anthropometric characteristics, as well as their performance of specific functional swimming capacities in pre-puberty developmental phase. Such data might provide an understanding of the general and specific water polo player's development process, which should be considered by coaches of youth players to improve their skills as a result of developing better training programs. Specific functional swimming capacities can be best trained because they are more modifiable, while the anthropometric characteristics should be sought in the process of identification and selection of talented players (height, arm span, extremities length). Still, those variables can only serve as possible prerequisites for the development of successful

water polo player along with well-developed agility, speed, accuracy, coordination, game intelligence, cognitive skills and anticipation.

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