STUDIES IN PHYSICAL CULTURE AND TOURISM Vol. 17, No. 4, 2010

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MAXIMAL STRENGTH AND STRENGTH ACCURACY IN WATER POLO PLAYERS FROM THE POLISH JUNIOR NATIONAL TEAM

Key words: maximal strength, strength accuracy, water polo players.

ABSTRACT

The aim of the paper was to determine maximal isometric strength (global and local), its time of development as well as global and local strength accuracy in water polo players. The research sample consisted of 12 water polo junior players representing the Polish Junior National Team (age 16.7 years; weight 74.8 kg; height 179.9 cm). Maximal global isometric strength as well as global strength accuracy were measured in a prone position. Maximal local isometric strength and global strength accuracy were measured in the elbow joint at approximately 90°. The players were characterized by an average level of maximal global and local isometric strength. Global and local strength accuracy may be considered a criterion in the process of selection of water polo players. In the measurements, the time during which maximal and optimal left arm strength was obtained was the shortest, whilst the level of strength accuracy was the lowest. It can confirm a somewhat one-sided choice of training measures which take into account the dominant limb only.

INTRODUCTION

Water polo, though not as popular as other team games, enjoys a considerable interest among the small group of its supporters in Poland. In many other countries its popularity is much greater, and multiple research studies have been conducted on water polo players.

In sport practice, it is important to pinpoint the level of maximal muscle strength, which enables the coach to establish a player's position within the team. It is also one of the criteria of assessment of fitness of players who have just taken up or continue practicing a given sport.

Studies of water polo players have been concerned with analysis of tactical assumptions –

especially the approach to attack and its efficiency [1] – players' anthropometrical characteristics [13], influence of fatigue on choices made by players and their scoring abilities [5], and the intensity of the game in relation to players' positions [4].

Water polo is considered a complex sport with regard to coordination abilities. In such sports primary importance is also attached to athletes' cardiovascular motor abilities. It is the very combination of these coordination and cardiovascular abilities that is seen by many theorists and practitioners as the key to success [6, 7, 10]. However, research studies aimed at determining the level of maximal strength and strength accuracy in water polo players have been very scarce [2, 3, 8].

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Water polo requires high levels of maximal and optimal strength, the latter being connected with its precise dosage. Frequently repeated movements of varied strength and the necessity to adjust them to the changing conditions during the game are decisive for water polo players' successful performance. This ability manifests itself in precise movements, dependent on the ability to manifest maximal strength quickly as well as the ability to dose it properly, i.e. strength accuracy.

The present study was carried out with a view to: 1. Determine the level of maximal global and local isometric strength; 2. Assess the time of maximal global and local isometric strength growth in relation to the maximal or optimal manifestation of strength; and 3. Pinpoint the level of global and local strength accuracy.

The following three research hypotheses were formulated:

- 1. Water polo players are characterized by an average level of maximal global and local isometric strength;
- 2. The time of maximal global and local isometric strength growth varies, depending on the necessity to manifest maximal or optimal strength;
- 3. The best Polish junior water polo players demonstrate a low level of global and local strength accuracy.

METHODS

The research sample consisted of 12 junior water polo players, members of the Polish national team (Tab. 1). The measurements of maximal global isometric strength and global strength accuracy were taken in a prone position on a vertical bench [6, 14, 15] (Fig. 1). Maximal local isometric strength and local strength accuracy were measured in the elbow joint, in a stable angular position approaching 90° [11]. A tensometric dynamometer coupled with an analogue-digital converter and a PC was used for measurements. The value of force was measured with 0.1 N accuracy, and its growth time was trialed every 0.005 sec. Strength accuracy was estimated on the basis of the ability to reconstruct half the value of the maximal strength according to the formula in Rynkiewicz [6]. The results were subject to statistical analysis with the aid of STATISTICA 8 software package (Statsoft, Inc. USA). Arithmetic

308

means, standard deviations and maximum and minimum values were calculated as well as the level of statistical significance between the studied parameters was determined.

Table 1. Basic characteristics of the subjects (n = 12)

Characteristic	М	SD	Min.	Max.
Age [years]	16.7	0.7	15	17
Body height [cm]	179.9	6.7	167	190
Body weight [kg]	74.8	11.2	57	95



Figure 1. Site for measuring maximal global isometric strength and global strength accuracy [7]

RESULTS

The level of the ability to manifest maximal global and local isometric strength was estimated. Slight differences between strength values typical of the left arm and the right are were noticed; however, they were statistically non-significant (Fig. 2). An analysis of correlation coefficients between maximal strength and strength accuracy among the subjects was carried out; however, it did not yield statistically significant results.

The obtained average values of global and local strength accuracy did not differ in a significant way. A higher level of strength accuracy was recorded in the global measurements (Fig. 3). Presumably, the lack of statistically significant differences resulted from a great variety of individual results (Fig. 3).



Figure 2. Average values of maximal global and local isometric strength of water polo players (n = 12)



Figure 3. Average values of global and local strength accuracy in water polo players (n = 12)

The individual values of maximal global and local statistical strength in the studied water polo players were decidedly less dispersed than those of strength accuracy. Therefore, coefficients of variability were calculated in order to compare the dispersion of individual results of measurements of strength and strength accuracy. The results analysis confirmed distinct differences with respect to the dispersion of individual features of the strength and strength accuracy values (Fig. 4). The average values of the time necessary to obtain maximal and optimal global isometric strength were similar (Fig. 4). It was observed that the time necessary to obtain maximum and optimal local isometric strength by the left arm was shorter than the values of by the right arm. These differences, however, were statistically non-significant. It is worth noting that in tasks devoted to obtaining optimal strength the subjects aimed at achieving half the value of maximum strength only.



Figure 4. Coefficients of strength variability, strength accuracy and the time of strength growth in water polo players (n = 12). MIS – maximal isometric strength [N]; MIS-R – maximum isometric strength of the right arm [N]; MIS-L – maximal isometric strength of the left arm [N]; SA – strength accuracy [%]; t $\frac{1}{2}$ – maximal isometric strength-time needed to obtain half the maximal isometric strength [s]; t – maximal isometric strength [s]; t – optimal strength-time needed to obtain half the optimal strength [s]; t – optimal strength [s]



Figure 5. Time needed to obtain maximal global and local isometric strength and halves of its values in water polo players (n = 12). Fmax – global – maximal global isometric strength [N]; Fmax – R – maximal isometric strength of the right arm [N]; Fmax – L – maximal isometric strength of the left arm [N]; Fopt global – optimal global isometric strength of the right arm [N]; Fopt R – optimal isometric strength of the right arm [N]; Fopt L – optimal isometric strength of the left arm [N]

The reverse were the trends in the time necessary to obtain half the strength. Lower time values were typical of tasks which required the manifestation of maximal strength, as opposed to optimal strength (Fig. 5). The differences, however, were statistically non-significant.

DISCUSSION

In contemporary sport it is increasingly important to achieve not only maximal but also optimal strength values. Not all players are capable of manifesting simultaneously a high level of these two aspects of motor abilities. Some athletes are characterized by an excessive "contribution" of strength to the performed movement. This applies both to muscles indispensable whilst moving as well as to those whose engagement is not justified. The former would indicate imprecise intermuscular control, whilst the latter intra-muscular one [10].

In water polo, particularly while performing acyclic movements, maximal strength is of lesser significance than the short time of its growth. In the case of movement-oriented tasks, in which the achievement of high values is of primary importance (e.g. water jumps), a short time during which maximum strength is obtained will play a more significant role. In tasks where lower values are more significant, a greater role will be played by the short time during which half the strength is achieved [12, 16]. In sport practice it is essential that an individual analysis should be conducted since the average values do not reflect the phenomenon in a sufficient way, especially with regard to features whose results are individually dispersed. In the present research a considerable variety of sports results typical of certain players was observed in the measurements of both global and local strength accuracy. It was decidedly higher than that typical maximal strength values.

It appears that in water polo a high level of strength accuracy in activities of global and local nature is useful. The ability to reconstruct precisely the targeted value of strength seems to be more useful for diagnosis of water polo players than the ability to develop maximal strength. Nevertheless, a high level of strength accuracy was typical of few subjects only. It may bear out the fact that the team was inappropriately assembled, and included players whose ability to dose muscular tensions was insufficient. This ability is crucial to manifest strength precisely.

The time needed to obtain maximum global isometric strength was only slightly longer than the time necessary to obtain the strength value perceived by the subjects as 50% of maximal strength (Fig. 5). Movement-oriented tasks of optimal nature of muscle activity were characterized by lower dynamics of strength growth in the initial phase of the movement (Fig. 5). Therefore, an additional setback in the form of reconstruction of the targeted value of strength is complicated enough to require setting up an appropriate movement program. And it takes more time for the program to be realized. This confirms previous observations concerning the movement mechanism of varied levels of ability to realize them [6, 9]. The time of growth of maximum strength and the time needed to obtain half of its value were not correlated. This implies that one may boast outstanding skills with respect to obtaining the highest values of strength or quickly manifesting little strength. The shorter time needed to obtain one half and 100% of optimal strength, typical of tasks performed by the left arm – weaker in the subject group - accounts for the lack of appropriate movement programs connected with the activity of this limb [9].

Errors in the measurements of local nature for the arms suggest a lack of properly developed movement programs, which presumably results from performing much too few varied exercises, possibly limited to the dominant limb. They also imply a need for the individualization of training tasks, indispensable to develop primary determinants of the quality of movement, i.e. strength accuracy of time and space. The reconstruction of the targeted value of strength requires the engagement of various muscle fibers. Lower strength values are reconstructed during a substantial activity of slow twitch fibers, predisposed to the development of lesser values of strength [7]. An attempt to obtain maximal or optimal strength as quickly as possible requires stimulation of a greater number or an appropriate number of motor units, which most often results in the tension of a vast majority of muscle fibers of slow twitch and fast twitch fibers. This, together with a lack of time for the realization of the movement program for the reconstruction of the targeted strength, may be the reason why the time needed to perform these tasks was the shortest. One may infer that the lower level

of strength accuracy of the left arm is the ensuing effect.

The analysis of the obtained results enabled us to draw the following conclusions:

- 1. The results do not make it possible to conclude that the development of maximal global and local isometric strength in water polo players was sufficient. This may also be attributable to the little significance of this motor ability in water polo players.
- 2. The level of global and local strength accuracy facilitates the selection of those water polo players who will boast one of the primary determinants of the quality of movement, i.e. strength accuracy.
- 3. The time needed to obtain maximal global isometric strength and optimal isometric strength was different. It confirms the fact that while performing tasks of optimal nature for muscular activity, there is a need to have sufficient time to realize appropriate movement programs. In the local measurements of strength and strength accuracy the time needed to obtain maximal and optimal strength in exercises performed by the left arm was the shortest; however, its level of strength accuracy was the lowest.

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