Original article

PHYSIOLOGICAL PROFILE OF ELITE WOMEN WATER POLO PLAYERS

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The present investigation aimed to determine the physiological profile of the best female water polo players in Serbia, with the purpose to use the obtained results as a guideline in the process of selection and planning of the sports form development. The parameters which should show physiological adaptation to specific kind and type of training were followed during preparatory period before the 2006 European Championship. Twelve water polo players (mean+/-SD: age 23.8+/-3.1 years, height 173.2+/-3.9 cm, body mass 65.7+/-7.4 kg, fat mass 17.8+/-5.3) of the Serbian women's national water polo team participated in the investigation. The results of our investigation show great anaerobic capacity and muscular strength of upper body (mean+/-SD: peak power 8.05 +/-0.8 $W.kg^{-1}$, mean power 6.5+/-0.4 $W.kg^{-1}$, very high aerobic endurance (mean+/-SD: VO_2(max) 46.52+/-7.0 mL O_2 ($min^{-1}kg^{-1}$) on arm ergometer, VO_2 (max) 61.8+/-11.9 mL O_2 ($min^{-1}kg^{-1}$ on leg ergometer)) and high values of lung function parameters. The great strength of the upper body and pronounced aerobic endurance of the whole organism are dominant characteristics of elite female water polo players. Along with a relatively pronounced body height, and a low percentage of the fat tissue, these female athletes are very well predisposed for adaptation on great physical demands over the whole match. *Acta Medica Medianae 2007;46(4):48-51.*

Key words: *water polo, training, strength, women*

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Introduction

Water polo is a team sport and represents a unique combination of swimming, throwing ball and fighting skills (1). That is what makes the modern water polo close to its roots of origin as "rugby in the water". Water polo along with football, rowing, and cricket has been introduced to the modern Olympic Games since the 1900 Olympic Games in Paris (2). This has given the longest tradition of Olympic team competition to this sport. However, the above mentioned refers to the male water polo alone. Female water polo was introduced as an Olympic sport exactly 100 years later, only to the 2000 Olympic Games in Sidney. Serbia and the Former Yugoslavia have had a long and successful tradition in water polo. Three gold Olympic medals, two times World champions, four times European Champions, and three times the FINA World Cup winners are only some of many achievements in the most significant international competitions. Serbia is one of a few countries with organized competition system in the pre-puberty category (10-12 years of age) (3). All this refers to the male water polo. Despite a long and successful tradition in the male water polo, recognized to both schools and coaches, the female water polo has neither long nor that successful tradition. Poor organization of work in the clubs, insufficient quality of the national competition system, and the generally small number of members cause the lack of significant results of the Serbian female water polo.

The present investigation aimed to determine the physiological profile of the best female water polo players in Serbia, with a purpose to use the obtained results as a guideline in the process of selection and planning of the sports form development. The same as in the similar investigations (4,5,6), the parameters which should show physiological adaptation to specific kind and type of training were followed.

Methods

Subjects. Twelve water polo players of the Serbian women's national water polo team, excluding goalkeepers, participated in the investigation. All of the subjects were elite women water polo players with a long-term sports career. The investigation was carried out during the final phase of the preparation period for the 2006 European Championship which was

held in Belgrade, Serbia. All of the subjects were presented with the relevant information in written form regarding the aims, course, participation and possible unwanted side effects of the investigation. All of the subjects voluntarily gave their written consent to participate in the investigation, and underwent a general physical examination.

Procedures. Body height was measured by means of an anthropometer (GPM, Switzerland) and in accordance with standardized procedure (7). Body weight was measured by means of electronic scales (Tefal, France) with an accuracy within 0,1 kg. The percentage of fat mass was measured by bioelectrical impedance analysis (8,9) and the device BF300 (Omron, Japan) was used. Data regarding percentage of fatty tissue were read off the display with an accuracy of 0,1%. The anaerobic capacity parameters were determined by the "all-out" 30-s anaerobic Wingate test (10,11). For this purpose, an arm cycle ergometer (Monark, Sweden) equipped with an electronic measuring device with a display was used. The setting up of the equipment and the subjects' warm-up carried out according to the standard (10). Data registration was carried out with the help of a specially designed computer program on the basis of the standards devised by the author of the test and the published technical description of a system for registering data by means of a computer (12). Maximum oxygen uptake (VO2max) was estimated by a method of extrapolation after a standardized submaximal test on the leg cycle ergometer (Kettler, Germany) and arm cycle ergometer (Monark, Sweden) along with telemetric monitoring of heart function (Polar, Finland). The setting up of the equipment and the subjects' warm-up carried out according to the standard (13). The duration between tests on different cycle ergometers was at least two hours. The VO2max testing was carried out at least 24 hours after the the execution of the "all-out" Wingate test. A computerized spirometer (Spirocomp, Germany) was used to monitor respiratory functions by means of the FVC, FEV1.0 and PEF parameters. The subjects were required to perform FVC maneuvers on a computerized spirometer according to the standard (14) in a total of three measurings. The greatest values FEV1.0 were used as the resulting values. All of the testing was carried out in the morning hours, in a room where the temperature was 21-23°C, and the humidity was 55-60%, so that microclimatic conditions suited the standards for laboratory functional testing (7,13). In order to process the results of the study, the SPSS statistical program for Windows (Release 10.0, Chicago, IL, USA) was used.

Results

The anthropometric characteristics of subjects and the results of physiological variables are presented in Tables 1 and 2. All results are presented as means±SD.

Table 1. Anthropometric characteristics of Serbian best female water polo players (n=12)

Variables	means X±SD
Age (years)	23.8±3.1
Sports experience (years)	7.4±3.9
Body height (cm)	173.2±3.9
Body weight (kg)	65.7±7.4
Body fat content- BIA (%)	17.8±5.3

Table 2. Physiological variables of Serbian best female water polo players (n=12)

Variables	means X±SD
Mean power (W)	430,56±58,8
Mean power (Wkg^{-1})	6.5±0.4
Peak power (W)	528.76±70.2
Peak power (Wkg^{-1})	8.05±0.8
VO_{2max} ($mlkg^{-1}min^{-1}$) on arm ergometer	46.52±7.0
VO_{2max} ($mlkg^{-1}min^{-1}$) on leg ergometer	61.8±11.9
FVC (L)	5.7±0.6
FEV1.0 (L)	4.6±0.4
PEF (Ls^{-1})	8.5±1.0

Discussion

Physiologically a highly demanding sport, water polo is composed of the interchange of very intensive activities shorter than 15 s in duration which is followed by the activity periods of lower intensity shorter than 20 s in duration (15). The investigations conducted in the male water polo showed that water polo has become physically more demanding than ever before (15,16). The development of sports form in water polo represents the combination of different types of training in water and on land. The management of the sports form is ment to provide optimal preparation of a player at a given time. For such management of the sports form it is necessary to know the hierarchical structure of anthropological abilities and players' characteristics. To be able to define the preparation pattern, it would be necessary to know the players' psychophysical resource. That is why it is important to obtain as much feedback information as possible on the level of ability and characteristics of players in certain phases. Only the training process based on the cybernetic approach (feedback theory) can provide a response to how to construct the training.

The preparation which enables the player to fulfil tasks tactically and technically in a high rhythm is conducted in the water. The technique of movement in an attack with and without a ball, the technique of movement in defence, the technique of movement back center, counter-attack 5:4 and 6:5, etc..., a player more-less demand a lot of time and repeating in the trainings in a low and high competition tempo, and all this in conditions which simulate the match situations. The achievement depends on the reliability of the technique in the finish of the match. If the player is not sufficiently physically

prepared, he will not be able to attack, defend or to fulfil the requirements and expectations. Swimming trainings, individual, group, and team trainings, with or without a ball, demand a lot of time (sometimes 180 min) which cannot be realized without a good aerobic preparation. The entire course of the sports form development is followed by dynamic power training with free external load because of the duel game and its outcome on which the advantage in the final phase of an attack or defence is dependant. Because of the stated above, the water polo training belongs to a group of concurrent training (17). During the concurrent training aiming to increase the muscle mass and muscle endurance, the muscle tissue undergoes two different types of adaptation. The training of endurance development increases the activity of aerobic enzymes and the density of mitochondria, whereas the training of strength development increases the ability of muscle power generation, but also decreases aerobic enzymes (18,19). On the occasion of conducting the concurrent training of endurance and strength development, the optimal adaptation of muscle fiber is made more difficult then it would be in the case of conducting only one type of training. In addition, the concurrent training of strength and endurance development can lead to overtraining because the athlete is subjected to a higher training load than on the occasion of only one type of training (20). This is considered to be a reason why athletes fail to achieve optimal adaptations during the concurrent training.

A small number of available investigations showed only that the members of the Serbian female national team were younger and higher then the female water polo players included in the similar investigation (21). Contrary to expectations, the percentage of fatty tissue was lower than the adequate for gender and age (22). On the basis of anthropometric characteristics, it can be concluded that the body constitution of female water polo players was similar to the constitution of women in competition swimming. Mean and peak (maximum) power values expressed in absolute and relative values were significantly higher then the average values for gender and age (10). The obtained results of the parameters of anaerobic capacity were expected considering the kind of training process which included swimming and training with ball. The values of maximum oxygen consumption (VO2max) on the arm bicycle ergometer were high even if compared with standards set for men of the same age (23, 24), indicating good adaptation to endurance trainings focused on the upper body. The results of the maximum oxygen consumption on the leg bicycle ergometer showed high physical fitness for aerobic demands. Parameters of lung function were also significantly high in relation to standards for corresponding gender and age (25). The results obtained in the present study represent a quantitative review of the physiological adaptation of the elite female water polo players to physical demands over several years lasting specific training process.

The results obtained are supposed to be used as a guideline in the planning and periodization of the training process in the female water polo. Of course, physical preparation and adequate adaptation to training are only some of the constituents of the sports form required for the success in water polo. Load optimization in training and perfecting the technical and tactical elements together with adequate physiological preparation and motivation are necessary for the final success. We consider that, as in other sports, monitoring and control of physiological parameters during the period of the sports form development, and competition preparation are necessary prerequisites for good competition achievements.

Conclusion

The great strength of the upper body and pronounced aerobic endurance of the whole organism are dominant characteristics of elite female water polo players. Along with a relatively pronounced height, and a low percentage of the fatty tissue, these female athletes are very well predisposed for adaptation on great physical demands over the whole match. The shown results may serve as a guideline for the planning and periodization of the of the sports form development in the female water polo.

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FIZIOLOŠKI PROFIL VRHUNSKIH VATERPOLISKINJA

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Pred Evropsko prvenstvo 2006. godine sprovedeno je istraživanje usmereno na određivanje fiziološkog profila najboljih vaterpoliskinja Srbije, s ciljem da se dobijeni rezultati koriste kao jedna od smernica u procesu selekcije i planiranja razvoja sportske forme. Praćeni su parametri koji treba da pokažu fiziološku adaptaciju na specifičnu vrstu i tip treninga. Istraživanje je obuhvatilo ukupno 12 ispitanica (X+/-sd: starost 23.8+/-3.1 godina, visina 173.2+/-3.9 cm, težina 65.7+/-7.4 kg, masno tkivo 17.8+/-5.3), članica vaterpolo reprezentacije Srbije. Dobijeni rezultati pokazuju veliki anaerobni kapacitet i ispoljenu mišićnu snagu pri anagažovanju gornjeg dela tela (X+/-sd: maksimalna snaga 8.05 +/-0.8 $W.kg^{-1}$, prosečna snaga 6.5+/-0.4 $W.kg^{-1}$), vrlo visoku aerobnu izdržljivost (X+/-sd: VO_2(max) 46.52+/-7.0 mL O_2 ($min^{-1}kg^{-1}$) na ručnom ergometru, VO_2(max) 61.8+/-11.9 mL O_2 ($min^{-1}kg^{-1}$) na nožnom ergometru), uz nadprosečne vrednosti parametara plućne funkcije. Velika snaga gorneg dela tela i izražena aerobna izdržljivost celog organizma su dominantne karakteristike vrhunskih vaterpoliskinja. Uz relativno izraženu telesnu visinu i nizak procenat masnog tkiva ove sportiskinje poseduju vrlo dobre predispozicije za adaptaciju na izražene fizičke napore tokom celog meča. *Acta Medica Medianae 2007;46(4):48-51.*

Ključne reči: *vaterpolo, trening, snaga, žene*