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## **The Influence of Various Types of Water Gymnastics Upon the Exercise Capacity**

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### **Abstract**

Between the components of the physiological capacity and the practice degree of the physical exercise is a direct interrelation, which is influenced by a number of factors, out of which deployment environment with its features has a leading role. Determining the relationship between the effort capacity by heart rate changes during recovery after exercise, determining the body aerobic resistance level, as a result of the entertaining and recreational activities, specifically, performed in different environments: terrestrial and aquatic, using adapted exercises and innovative materials, that require various and specific efforts.

The study was conducted during the academic year 2012-2013, with the female students in the first year of the non-profile faculties and comprised two experimental groups of 24 subjects each, from UMF Tg. Mures, who carried out specific water gymnastics activities, during physical education classes and a control group composed of 47 female students from Transilvania University of Brasov, who carried out the following: entertaining and recreational activities, application exercises, overall physical development free exercises or with portable objects. During the research, the Ruffier test was applied with target on the body aerobic resistance level. Following the research performance, the Ruffier index recorded the biggest difference of the averages of 1.75, after practicing aqua-pullpush-gym activities.

**Keywords:** Water gymnastics, various environments, effort capacity.

## Introduction

The introduction of technological innovations in materials and sports facilities induce multiple effects such as: various efforts to carry out motor tasks, increasing the attractiveness and active involvement of students in performing motor tasks, programs diversification, etc., all this being a response to modern trends of efficiency increase in education. (Badau A et.al. 2015,p. 236).

For Takeshima et al. (2002, p. 543) water exercise produces different physiological reactions to those performed on the ground. This is due to the hydrostatic water effects on cardio-respiratory systems, in response to the process of thermoregulation.

Shono et al. (2001, p. 270) argue that the speed and performance have a significant effect on several physiological parameters indicating: the subjective perception of effort, heart rate and  $VO_2max$ . Generally, the effort in water environment favours biological development (improving cardio respiratory capacity and aerobic resistance, stimulating the metabolism, etc.and motor development (toning, relaxation, mobility, etc.) with effects on the improvement of life quality(Moisés G. P., 2010, p. 27).

We consider water gymnastics a system of exercises practiced analytically and globally, within the water environment which influences the locomotive system on a precise and selective manner, aiming towards a harmonious physical development, motor capacity, physiologic capacity development, health improvement and inferentially life quality (Badau A si colab, 2015, p. 236).

Some studies have noted significant improvement in muscle strength, after programs with a period of 8 weeks (Robinson L. et al, 2004), (Colado J.C. et al., 2009b), 10 weeks (Poyhonen T. et al., 2002), 12 weeks (Takeshima N. et al., 2002), (Bocalini D.S. et al., 2008) or after 24 weeks (Colado J.C. et al., 2009b) in the case of healthy, sedentary women.

According to Colado J.C. S. et al.(2001, p.14) „for a correct approach to the water activity type, it is necessary to perform aerobic exercises around the "effort area or heart rate effort range, (made by Sova, 1993), which means 60-90% of the maximum exercise capacity of a person". Another important guiding mark in assessing the exercise capacity index which "is considered the most obvious indicator of exercise intensity, is the subject's perception upon it" (Sova 1993, quoted by Duarte, A.F., 2009, p. 81).

**Table 1.** Exercise capacity index in water environment (adapted by Borg and Harre, 1998)

FC of exercise	Auto-perception	% $VO_2max$
70 bpm	Very, very light training	25%
90 bpm	Very light training	30%
110 bpm	Slightly light	40%
130 bpm	Almost tough	50%
150 bpm	Tough	75%
170 bpm	Very tough	anaerobe
190 bpm	Very, very tough	collaps

In conclusion we believe that the optimum effort in practicing water gymnastics should be between the levels "almost tough - tough" with values between 130-150 pulse / min., in order to reach the expected results, through the heart rate indicator. Aqua-gym represents an innovative method of motor education technology, being adaptable to particularities specific to age and training level, as well as to individual and group preferences, contributing to optimum modification of behaviours and physical capacities.

Aqua-gym represents one of the modern trends of physical exercise practice through the combination of various simple and complex action systems, adapted to the positive influences of the water environment and by using materials such as: sticks, ankle sandbags (Badau et al., 2012).

Aqua-pullpush-gym, a newly conceived activity, involves a combination of various simple and complex action systems, adapted to the individual particularities and water environment, with complex impact upon physical condition and health, combining simple movements with complex movements of body segments, using pull-push paddles and fixopié accessories. This activity is recommended at persons above 18 years of age, no matter the gender, weight or physical training. "The exercises with portable objects will amplify the effects of the regular physical exercises, allowing a more precise control over the segments movement and of the entire body" (Badau A.& Bădău D., 2011).

## Hypothesis

To set the hypothesis it was started from the assumption that the performance of gymnastics in water: aquagym and aqua-pullpush-gym, will improve the aerobic capacity.

## Material and Methods

### 1. Period and place of the research

Two independent variables were used for the experimental plan of the research. They consisted in the educational strategy for the improvement of somatic indices, of motor and functional capacity, by selecting the methods and action means specific to water activities: aqua-gym and aqua-pullpush-gym.

The research took place throughout the entire university year October 2011-May 2012 and consisted in a 50 minutes class, held once a week.

The research contains two tests as follows:

- initial test (Ti): 10-21 October 2011;
- Implementing the suggested ludic recreational water activities on the experimental group: 24 October 2011- 11 May 2012.
- final test (Tf): 14 May-26 May 2012.

The operational aqua-gym and aqua-pullpush-gym programs were divided into three levels: beginners, intermediate and advanced, depending on difficulty degree, intensity and complexity of action systems.

### 2. Subjects and groups

The research was carried out on 95 subjects organized in three groups: two experimental groups and one control group.

The experimental groups were made of 24 first year female students, from the University of Medicine and Pharmacology in Targu Mures, with ages between 19 and 23 years old. The first group (E1) executed a specific program of aqua-gym activities, while the second experimental group (E2) executed a specific program of aqua-pullpush-gym, activity newly elaborated.

The control group (C) consisted of 47 first year female students from the Transilvania University of Brasov, aged 19-23, from non-sportive specialties; the subjects carried out physical education classes held in the gym, where they practiced the following activities: applied exercises, freestyle exercises for the general physical development, exercises with portable objects and dynamic games.

### 3. Test applied

The data was statistically processed with the software IBM SPSS Statistics 20 for Windows. In order to analyse the reaction time, we calculated: mean (X), standard deviation (SD), variation coefficient (Cv), Student's t-test (T).

Ruffier test: this test aims to assess the exercise capacity by changes in the heart rate during recovery after effort, determining the body's aerobic resistance; it is a selection test.

Technique: subject in "sitting" position, pulse is recorded for 15 seconds which is multiplied by 4 in order to report per minute, resulting P1 constant (resting heart rate); the subject then performs 30 squats in 30 seconds, after which he takes the original position; pulse per 15 sec is measured, between 0 and 15 seconds post-effort in order to report per minute, resulting constant P2 (pulse of effort); subject remains seated for 1 minute, the pulse is measured again for 15 sec which multiplied by 4 gives P3 (pulse return).

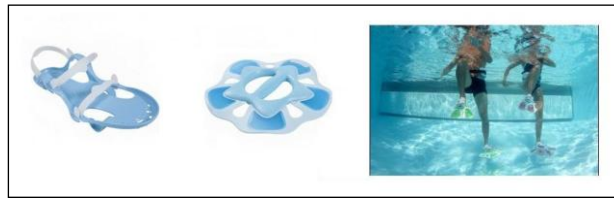
This formula is applied:  $I.R. = (P1 + P2 + P3) - 200/10$ .

Interpretation: values lower than 0 (negative) = very good; values between 0-5 = scoring-good; values 5, 1 - 10 = scoring – average; values between 10.1 to 15 = 15 = satisfactory, values over 15= unsatisfactory, which require additional cardiovascular investigation.

### 4. Used materials:

In water gymnastics, various materials are used which serve the objectives, requiring additional efforts both as cargo and as handling, with an ergonomic and modern design, a variety of shapes and colors.

The new aqua-pullpush-gym activity uses exclusively pull-push paddles, made by Decathlon, composed of SEBS and polypropylene, and characterized by a hydrodynamic shape like a flower, with five "petals" of 37cm in diameter, on the centre having an ergonomic handle to hold, slightly rough to prevent slipping. In order to execute exercises for the inferior limbs these also have an accessory called fixopié, which can be fixed on the soles and which looks like sandals, provided with two clips disposed on complementary directions in order to facilitate its fixing with a twisting action.



**Figure 1.** Fixopie and pullpush paddle(image taken from <http://www.decathlon.ro/content/70-fixopie>)

The main differences between the two activities consist in the used materials, their design and the usage percentage during class.

Therefore, aqua-pullpush-gym uses the pull-push paddles during the entire fundamental part, around 35 minutes, when these are held in hands in order to work on the upper body part, fixed on the soles for the lower body part or both held and fixed.

Aqua-gym has a compound structure for the fundamental part: the aerobe part of 15-20 minutes when free exercises are carried out, and the localized part of 10-15 minutes with the purpose to train the strength and endurance of muscle segments; various materials can be used to increase their efficiency, such as: palmers, sand bags, sticks etc.

#### 5. Content examples of the programs applied:

During the sessions, for each of the two activities: aquagym and aqua-pullpush-gym, we designed, selected and applied a wide range of action means, grouped according to their value, from which we present some exercises for medium level:

##### E1-Aqua-gym – intermediate level

###### Aerobe part (25 min.)

- PI: Standing position, arms on the side, submerged below water surface. Taking the arm forward and dynamically lowering the left arm. Return to starting position, similar moves but on the opposite direction.
- Running with knees up or sideways on the spot or shift.
- PI Standing. Jumps with knees up and sideways.

###### Localized part(10-15 min.)

###### Exercises with sand bags attached to ankles

- Running versions: normal running on the spot; running with knees up or sideways, on the spot; running while swinging leg forward, on the spot; running with swinging leg backwards on the spot; running with added step; running crossed step; running step, skipped shift.
- PI. Standing, arms above as a crown. Lifting the right leg, bent on the side with the descent of the arm on the same side, behind the knee, followed by a return to the original position; the same movements on the opposite side.

##### E2-Aqua-pullpush-gym- intermediate level

###### Exercises with plates kept in hands

- PI: Standing, arms on the lateral, plates vertically immersed in water. Executing a simultaneous movement to carry arms forward.
- PI: Standing, arms bent at 90 degrees on chest level, with pullpush plates placed on the water surface. Executing an alternative pushing motion of the arms downwards.
- PI: Standing, right arm stretched forward, left arm backwards, plates on the water surface. Executing a rocking motion of the arms alongside the body.

Exercises with plates attached to soles

- PI: Standing widely anterior-posterior, right foot forward, and arms bent with hands on hips, plates attached to soles. Executing anterior-posterior track by stepping with the left leg forward and return to start position.
- PI: Standing, arms bent, forearms facing forward. Executing alternative leg crossing forwards.
- PI: Standing sideways, fixed plates, right arm bent grabbing the edge of the pool, left arm bent, hand on hip. T1 - lifting left foot forward, T2, 4, 6 - return to starting position, T3 – lifting foot on the side, T5 - lifting leg backwards, torso tilted forward. The same movements on the opposite side.

Exercises with plates held in hands and attached to soles

- PI: Standing with plates attached to soles, arms bent sideways, plates positioned vertically oriented outwards. Executing an alternative motion of lifting bent legs backwards, simultaneously pushing the arms on the sideways.
- PI: Standing with plates attached to soles, arms bent at 90 degrees, forearms forward, plates positioned below the water surface, facing down. Executing an alternative lifting of legs bent back simultaneously pushing down the arms.
- PI: Standing, plates attached to soles, hands sideways, plates positioned below the water surface, face down. Executing alternative lifts of legs bent forward at the same time lowering down the arms sideways.

**Results and Discussions**

The research results were presented in the following tables to highlight the statistical significance of the studied parameters.

**Table 2.** Effort Capacity -summary of results

<b>Effort Capacity - Test Ruffier</b>							
Group	Cod	Motor activity	Average (X)		Difference Tf-Ti	CV (%)	
			Ti	Tf		Ti	Tf
Experiment	E1	Aquagym	10,42	9,19	-1,23	1,21	0,98
	E2	Aqua-pullpush-gym	10,49	8,74	-1,75	0,96	0,75
Control	C	DFG+EA+JD	10,53	9,77	-0,76	0,62	0,59

DFG- exercises for general physical development, EA- applied exercises; JD-dynamic games;

**Table 3.** Summary of average differences between research groups

Effort Capacity - Test Ruffier			
Group	Difference X		Difference X Tf-Ti
	XTi	XTf	
E2-E1	0,07	-0,48	-0,55
E1-C	- 0,11	-0,67	-0,56
E2-C	-0,15	-1,03	-0,88

*E1, E2 – experimental groups; C- control group*

**Table 4.** Analysis of statistical results of Student test ( $T_{value}$ )

Effort Capacity - Test Ruffier				
Group	Tests	$T_{value}$	P	Significance threshold
E1 – C	Ti	0,511	0,611	* not significant
	Tf	3,10	0,003	**significant
E2 – C	Ti	0,189	0,850	*not significant
	Tf	6,32	0,000	***highly significant

$p > .05$  \*  $p < .05$  \*\*  $p < .01$  \*\*\*

Statistical analysis indicates that all samples included in the research showed an improvement in aerobic exercise capacity between the two tests, evaluated with the Ruffier test.

Based on relatively equal values at initial testing, after carrying out the suggested programs, the following differences were obtained between test averages: 0.76 for the control group, 1.23 for the experimental group E1-Aquagym, and the experimental group Aqua-pullpush-gym- E2 1.75.

Reporting the average values to the assessment grid, it is noted that by the initial testing all groups included in the survey were at a satisfactory level, with values between 10.1 -15, and after the suggested programs, at the final testing they registered noticeable progress, reaching an average level, with values below 10.

The improvement of exercise capacity between the groups, in the course of research, reveals the following significant differences presented in Table no. 3, in favour of the experimental groups as compared to the control group: the progress difference between group E1 and control group is 0.56, and between E2 and the control group is 0.88.

Higher progress of experimental groups as compared to the control group is determined by the influences of independent variables applied. Calculation of the coefficient of variability both at initial testing and final testing reveals high homogeneity for all test samples.

The analysis conducted with t-Student test for paired samples, according to Table no. 4 shows a statistically significant difference for experimental group E1-Aquagym as compared to the control group, therefore  $p < 0.03$  is lower than  $p < 0.05$  rejecting the null hypothesis.

In the case of the experimental group E2-Aqua-pullpush -gym, comparing averages with those of the control group, statistical analysis shows a highly significant difference,  $p < 0.000$ , therefore the null hypothesis is rejected and the alternative hypothesis is accepted.

## Conclusion

The research targeted the exercise capacity and as a result it can be concluded that: the cardiac output determined by the Ruffier test registered improved results of both experimental groups as compared to the control group, due to the influences of independent variables and properties of water environment.

Practicing various forms of water gymnastics helps improve the aerobic exercise capacity, to superior indices compared to the activity on the ground, being directly influenced by materials used through the size of water surface contact and complexity of movements.

The water environment through its properties: viscosity, hydrostatic pressure, etc. impedes the motion depending on the contact surface, which leads to sustained efforts to succeed in handling objects used in water gymnastics



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