



**Conference Poster &  
Research Presentation Sessions**

**Aquatic Exercise Association  
2011 International Aquatic Fitness Conference (IAFC)  
May 10-14, 2011**

Proceedings Published by:  
World Aquatic Coalition, Inc.  
DBA Aquatic Exercise Association  
The AEA Research Committee  
[www.aeawave.com](http://www.aeawave.com)

*Conference Poster Sessions 2011*  
ISSN 2152-0534  
Published September 2011

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# Cardiorespiratory, neuromuscular, and kinetic responses to water aerobic exercises performed at different intensities.

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The aim of the present study was to compare oxygen uptake ( $\text{VO}_2$ ), electromyographic activity (EMG) of the rectus femoris (RF), semitendinosus (ST), vastus lateralis (VL), short head of the biceps femoris (BF), tibialis anterior (TA) and gastrocnemius lateralis (GL), and peak vertical ground reaction forces ( $F_{z_{\text{peak}}}$ ) responses of women performing water aerobic exercises at different intensities. A sample of 12 young women ( $23.8 \pm 2.2$  years;  $162.1 \pm 5.6$  cm;  $58.3 \pm 5.5$  kg) performed the experimental protocol, which consisted of three water aerobic exercises (stationary running (SR), frontal kick (FK), cross country skiing (CCS)) performed at three intensities corresponding to the first ventilatory threshold (VT1), second ventilatory threshold (VT2) and maximal effort (MAX) in a randomized order. The intensities were previously obtained based on performance of maximal progressive tests corresponding to the above mentioned water aerobic exercises. A portable gas analyzer (VO2000), an electromyograph (Miotool400) and a subaquatic force plate (AMTI) were used in order to measure the  $\text{VO}_2$ , the EMG signal and the  $F_{z_{\text{peak}}}$ , respectively. Two-way repeated measures ANOVA were used, with Bonferroni's post-hoc test ( $\alpha = 0.05$ ). Similar values of  $\text{VO}_2$  were found between exercises and significant differences ( $p < 0.001$ ) between the intensities VT1 and VT2. Regarding the EMG signal, significantly higher muscle activity of RF

( $p = 0.002$ ), ST ( $p = 0.034$ ), VL ( $p = 0.003$ ), BF ( $p = 0.004$ ) and GL ( $p = 0.013$ ) muscles were found for the FK, and lower for the SR, except in the TA muscle, which presented higher responses ( $p = 0.011$ ) for the CCS compared to the other exercises. Moreover, there were significant differences between intensities for all muscles ( $p < 0.001$ ). Analyzing the  $F_{z_{\text{peak}}}$ , a difference was observed between VT1 and higher intensities ( $p = 0.001$ ), and significantly lower  $F_{z_{\text{peak}}}$  values were observed for CCS compared to the other exercises ( $p < 0.001$ ). Thus, it is suggested that exercises with similar characteristics to the CCS must be prioritized if the aim is to attenuate the  $F_{z_{\text{peak}}}$  action, as it is important to highlight that this exercise presents intense neuromuscular activity in all the analyzed muscles, with the exception of GL. Moreover, with the intensity increased, higher cardiorespiratory and EMG activity responses were observed; however, with no difference in the  $F_{z_{\text{peak}}}$  between MAX and VT2. Notwithstanding, if the aim is to minimize the muscular activation, SR is recommended since it can be used during water aerobics with a similar cardiorespiratory intensity to the other evaluated exercises, while inducing lower peripheral fatigue.

**Keywords:** oxygen uptake; electromyographic activity, vertical ground reaction forces; immersion.

# Vertical ground reaction forces during water aerobic exercises performed in water and on dry land environments at different intensities.

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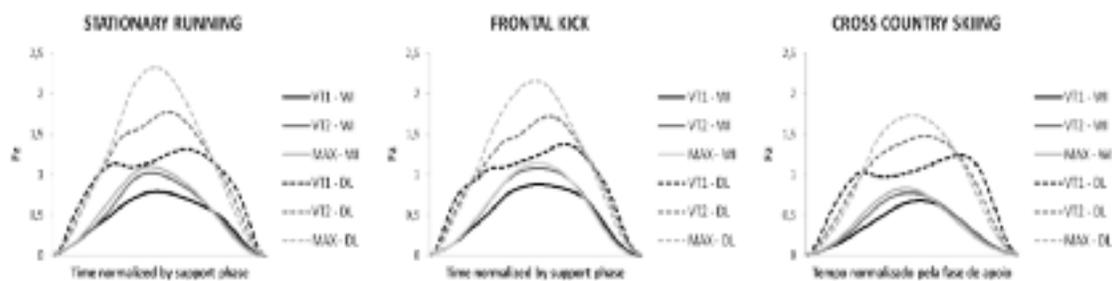
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The aim of the present study was to compare the vertical ground reaction forces ( $F_z$ ) of women performing water aerobic exercises at different intensities in water immersion (WI) and on dry land (DL). A sample of 15 young women ( $23.2 \pm 2.0$  anos;  $162.8 \pm 7.1$  cm;  $57.6 \pm 5.8$  kg) performed two sessions (WI and DL), each one consisting of three water aerobic exercises (stationary running (SR), frontal kick (FK), cross country skiing (CCS)) performed at three intensities corresponding to the first ventilatory threshold (VT1), second ventilatory threshold (VT2) and maximal effort (MAX) in a randomized order. The cadences corresponding to the intensities were previously obtained based on performance of maximal progressive tests corresponding to the above mentioned water aerobic exercises. A sub-aquatic force plate (AMTI) was used in order to measure the peak  $F_z$  ( $F_{z_{peak}}$ ) and impulse (IMP). Two-way and three-way repeated measures ANOVA were used to analyze the IMP and  $F_{z_{peak}}$ , respectively, with Bonferroni's post-hoc test ( $\alpha = 0.05$ ). Regarding ground reaction forces, significantly higher values of  $F_{z_{peak}}$  ( $p < 0.001$ ) and IMP

( $p < 0.001$ ) were observed for DL compared to WI. The temporal analysis of force x time is shown in Figure 1. Significant differences were observed between all intensities for  $F_{z_{peak}}$  ( $p < 0.001$ ) and IMP ( $p < 0.001$ ) on DL, and for IMP ( $p < 0.001$ ) in WI. Nevertheless, a difference was observed between VT1 and higher intensities for  $F_{z_{peak}}$  ( $p < 0.001$ ) in WI. In addition, in WI significantly lower  $F_{z_{peak}}$  values were observed for CCS compared to the other exercises ( $p < 0.001$ ). According to the results, the  $F_z$  is always lower in WI compared to DL. An important issue to be considered during water aerobics training is the exercise and intensity to be prescribed. Exercises with similar characteristics to the CCS and intensities corresponding to VT1 must be prioritized if the aim is to attenuate the  $F_{z_{peak}}$  action. On the other hand, there is no difference in the  $F_{z_{peak}}$  between MAX and VT2 in WI; thus the maximal intensity is as safe to use as the VT2.

**Keywords:** impact, impulse, immersion.

**Figure 1** – Mean force x time curve for different water aerobic exercises performed at cadences corresponding to the first ventilatory threshold (VT1), second ventilatory threshold (VT2) and maximal effort in water immersion (WI) and on dry land (DL).



# Determination of maximum oxygen uptake and ventilator threshold of six exercises of water aerobics in young women.

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The aim of this study was to analyze and compare maximal and corresponding to the 2nd ventilatory thresholds (VT) cardiorespiratory responses between frontal exercises of stationary running (SR), frontal kick to 45° (FK) and cross-country skiing (CCS) that have an emphasis on hip flexors and extensors. Beyond these, also the lateral exercises of jumping jacks (JJ), adductor hop (AdH) and abductor hop (AbH) that have an emphasis on hip adductors and abductors. Twelve young women performed six maximal test sessions (SR, FK, CCS, JJ, AdH, AbH) in randomized order with an interval of at least 24 hours between them. Repeated-measures ANOVA was used for analyses with Bonferroni's post hoc test, with  $\alpha = 0.05$  (SPSS v.17.0). The analysis showed no significant differences in maximal cardiorespiratory responses between frontal exercises. The cardiorespiratory responses for lateral exercises were dependent of the variable analyzed. Lateral exercises showed lower responses for  $VO_{2max}$  compared with

frontal exercises while only JJ showed lower responses for  $V_{emax}$  and  $HR_{max}$ . With regard of  $VO_2$  responses in the 2nd VT, JJ also showed significantly lower responses compared with the other exercises. Responses of  $\%VO_{2max}$  and  $\%HR_{max}$  in the 2nd VT showed no significant differences between exercises. Therefore it is possible to conclude that cardiorespiratory responses are directly related to muscle mass involved in the exercise, making it necessary to perform specific tests according to the exercise so that real cardiorespiratory responses can be observed and in order that the prescription might be safer and efficient. Moreover, when the responses were analyzed in a relative percentage of maximum effort, the intensity was the same for all exercises. Thus it is possible to assemble a water aerobics class for young women at a given intensity varying the six exercises analyzed.

**Keywords:** oxygen uptake, heart rate, water exercises.

# Maximal cardiorespiratory and second ventilator threshold responses to deep water running.

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Analysis of cardiorespiratory responses of exercises in the aquatic environment has gained relevance in recent years, mainly in order to optimize the prescription of these activities. Deep water running is an exercise that simulates running on land, carried without the support of the feet at the bottom of the pool and with the aid of a float vest. According to the specific characteristics of this activity, it is important for it to conform to the goals of practitioners studying the different cardiorespiratory responses. Thus, the aim of the present study was to compare maximal cardiorespiratory and second ventilatory thresholds (VT2) responses between maximal tests performed on a treadmill on land and in the deep water running, while also comparing two methods of determining the VT2 (ventilatory thresholds and Conconi test).

The study sample consisted of twelve young women ( $23.1 \pm 1.9$  years) that were familiar with the aquatic environment and free of physical disorders. All subjects performed a maximal deep water running test without displacement and maximal treadmill running test on land for the evaluation of maximal heart rate and oxygen uptake ( $HR_{max}$  and  $VO_{2max}$ ) and corresponding to the VT2 ( $HR_{VT2}$  and  $VO_{VT2}$ ). The data were analyzed using paired t test, two-way ANOVA for repeated measures, Bonferroni's post-hoc test and intraclass correlation coefficient test (ICC) ( $\alpha = 0.05$ ).

The results showed significantly greater values for the  $HR_{max}$  ( $p=0.002$ ),  $VO_{2max}$  ( $p<0.001$ ),  $HR_{VT2}$  ( $p=0.031$ ) and  $VO_{2VT2}$  ( $p<0.001$ ) in the test performed on a treadmill on land compared to the deep water running test. No significant difference between methods of determining the VT2 were found for both  $HR_{VT2}$  ( $p=0.844$ ) and  $VO_{2VT2}$  ( $p=0.113$ ), and the ICC values were high and significant for all variables (table 1).

It can be concluded that the cardiorespiratory variables at maximal effort and at the anaerobic threshold are lower in the maximal test performed in the aquatic environment compared to land. Furthermore, no differences were found between the methods for determining the VT2, showing that the determination from the Conconi test seems to be a very reliable and practical method. Thus, through the heart rate by the time graph it is possible to determine the deflection point, from which point, the percentage of heart rate corresponding to the desired training zone can be established.

**Keywords:** water exercise, ventilator threshold and Conconi test.

**Table 1.** ICC values and significance ( $p$ ) for heart rate ( $HR_{VT2}$ ) and oxygen uptake ( $VO_{2VT2}$ ) between the methods of determining the VT2 (ventilatory thresholds - VT and Conconi test - CT) in land and aquatic maximal tests.

Maximal test	Variables	CT		VT		ICC	P
		Mean	SD	Mean	SD		
Aquatic Environment	$HR_{VT2}$ (bpm)	153	$\pm 17$	152	$\pm 18$	0.944	$<0.001^*$
Land Environment	$VO_{2VT2}$ (l.min-1)	1	$\pm 0.30$	1.03	$\pm 0.31$	1	$<0.001^*$
Land Environment	$HR_{VT2}$ (bpm)	171	$\pm 6$	172	$\pm 6$	0.833	$0.003^*$
Land Environment	$VO_{2VT2}$ (l.min-1)	1.52	$\pm 0.31$	1.61	$\pm 0.34$	0.785	$0.004^*$

\* Statistically significant difference to  $p \leq 0.05$ .

# Submaximal cardiorespiratory responses to deep water running with and without displacement at different cadences.

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Currently, there is an increasing demand for water-based exercises, mainly for its health benefits. The deep water running, for example, is an exercise that simulates running on land performed without the support of the feet on the pool bottom and with assistance of a float vest. According to the specific characteristics of each activity, is important to adapt them to the goals of the practitioners studying the pattern of the cardiorespiratory responses.

Thus, the aim of the present study was to compare the cardiorespiratory responses during deep water running performed with and without displacement at different cadences (60, 80 and 100 beats per minute). The study sample consisted of twelve young women (23.1 ± 1.9 years) that were familiar with the aquatic environment and free of physical disorders. The heart rate (HR), ventilation (Ve) and oxygen uptake (VO<sub>2</sub>) were verified during the last minute in each exercise and the rate of perceived exertion (RPE) was collected in the ending of the exercise using the the Borg 6-20 scale. The data were analyzed using two-way ANOVA for repeated measures and Bonferoni's post-hoc test ( $\alpha = 0.05$ ).

According to Table 1, the results showed that the all variables increased significantly with increasing cadence. Furthermore, the VO<sub>2</sub>, Ve and RPE variables were significantly higher in the deep water running with displacement execution form. However, the HR did not show this pattern, with no differences between the forms. The results indicate that the increases in cadence and the displacement enhance the cardiorespiratory responses in the deep water running and this is an important result to adapt the prescription of this activity with the practitioner's purposes. Thus, it is suggested that according to the aim of the prescription, different speeds and displacement forms should be alternated. In an interval routine, i.e., deep water running without displacement in the RPE 11 (light – perceived exertion found in the cadence of 60 bpm in this situation) can be switched with deep water running with displacement in perceived exertion 17 (very hard – perceived exertion found in the cadence of 100 bpm in this situation).

**Keywords:** water exercise, heart rate, oxygen uptake, ventilation and rate of perceived exertion.

**Table 1:** Variance analyze of main effects cadence (CAD), execution form (FOR) and interaction factor (CAD\*FOR). Mean and Standard deviation (SD) of heart rate (HR), ventilation (Ve), oxygen uptake absolute and relative (VO<sub>2</sub>) and rate of perceived exertion (RPE) in different cadences (60, 80 and 100bpm) and in different execution forms (with displacement (DI) and without displacement (WD)).

		Execution Forms						
		DI		WD		CAD	FOR	CAD*FOR
Variables	Cadence	Mean	SD	Mean	SD	<i>P</i>	<i>p</i>	<i>p</i>
HR (bpm)	60 bpm	122	±20	115	±17	<0.001*	0.065	0.256
	80 bpm	136	±19	130	±22			
	100 bpm	156	±16	141	±23			
Ve (l.min <sup>-1</sup> )	60 bpm	15.63	±5.86	11.86	±3.46	<0.001*	0.001*	0.386
	80 bpm	21.59	±6.61	17.02	±3.63			
	100 bpm	31.22	±10.59	24.30	±8.91			
VO <sub>2</sub> (l.min <sup>-1</sup> )	60 bpm	0.72	±0.30	0.58	±0.27	<0.001*	0.047*	0.399
	80 bpm	0.91	±0.30	0.81	±0.33			
	100 bpm	1.19	±0.35	0.99	±0.35			
VO <sub>2</sub> (ml.kg <sup>-1</sup> .min <sup>-1</sup> )	60 bpm	11.51	±3.68	9.08	±2.97	<0.001*	0.028*	0.417
	80 bpm	15.46	±5.79	12.74	±2.94			
	100 bpm	20.13	±6.28	15.92	±4.56			
RPE	60 bpm	15	±2	11	±2	<0.001*	0.054*	0.341
	80 bpm	16	±2	12	±2			
	100 bpm	17	±2	13	±2			

\* Statistically significant difference to  $p < 0.05$ .

# Aquatic exercise improves pain and 6MWT in elderly patients with knee arthritis.

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Osteoarthritis (OA) is the most prevalent disease of the locomotor system, and a major cause of disability associated with aging. Pain is one of the main adverse symptoms of knee OA and is responsible for activity restriction, physical disability and loss of autonomy among older patients. Inactivity secondary to pain results in muscle weakness, atrophy, and deconditioning and therefore might accelerate the progression of knee OA. According to the recommendations of the Osteoarthritis Research Society International (OARSI), controlled exercise is an effective non-pharmacological treatment for OA and aquatic exercise seems to have an important role in pain management.

## Purpose

To evaluate the effects of an aquatic exercise program on pain and walking ability in patients with Knee OA grade II and III.

## Methods

From an initial group of 11 subjects, 9 subjects (63±7yrs, body mass: 70±8 kg) completed 12 weeks of aquatic exercise, twice a week. The aquatic program was adapted according the guidelines of Arthritis Foundation YMCA Aquatic Program. Walking ability was assessed by the 6 minute walking test (6MWT) at a rectangle walkway with 47meters. Scores of perceived exertion (Borg CR10 scale) and pain (numerical rating scale) were obtained during the 6MWT at four

moments: 0 (before test), 2', 4' and 6' (immediately after the end of test). Paired T-tests (two tailed) were used to assess statistical significance (level,  $p < 0,05$ ).

## Results

At 6MWT, the distance improved from 533±69 to 560±39m ( $p=0,05$ ) and pain score at the end of 6MWT decreased from 5,8±3,0 to 3,3±3,4 ( $p=0,068$ ) whereas perceived exertion remained unchanged. The progression of reported pain during 6MWT before exercise intervention was more accentuated (1,6 at 0'; 3,8 at 2'; 4,7 at 4' and 5,8 at 6') than after exercise intervention (0,6 at 0'; 2,0 at 2'; 2,6 at 4' and 3,3 at 6').

## Conclusion

Although this study is limited by the low number of patients and the lack of a control group, the results are nevertheless encouraging since they show that aquatic exercise can be effective for improving the walking capacity and reducing pain level.

This study was supported by a grant from Secretariado Nacional para a Reabilitação e Integração das Pessoas com Deficiência – SNRIPD

**Keywords:** Aquatic Exercise, Osteoarthritis, Pain,

# Comparison of cardiorespiratory and metabolic responses from two basic aquatic exercise patterns.

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## Introduction

Although many studies have showed the efficacy of aquatic exercise programs in physical fitness, there is a lack of consistent data about required methodology and exercise overload. For exercise prescription and methodology definition, more information is necessary about the acute effect of this type of exercise on cardiorespiratory responses according muscle recruitment, music tempo, exercise cadence and equipment used.

## Purpose

This study had 2 phases: **1<sup>o</sup>** The first phase had as a main goal to compare the effect of music tempo and exercise cadence in the performance of the Cross Country Ski pattern; this task was to find the best music tempo and cadence to develop the next phases. **2<sup>a</sup>** The goal of the second phase was to compare the cardiorespiratory responses between 2 basic aquatic exercise patterns when performed at the same music tempo and cadence gotten from phase one.

## Methods

Sample: 15 volunteers (22±2yrs), healthy and active students, with previous experience of aquatic exercise were included (Height: 1,70m± 0,1; Fat Mass: 14,4± 7% and BMI: 23±3 Kg/m<sup>2</sup>). The exclusion criteria were having a height which could compromise the water level range necessary for this study.

## Instruments

The expired air was measured to obtain oxygen consumption, carbon dioxide elimination rates and minute ventilation with a portable gas analyzer (K4b<sup>2</sup>, COSMED). The gas analyser was protected by a water proof box (aqua trainer). For the cadence music validation an electronic metronome was used. To register the effort two distinct methods were used: heart rate (by telemetry -Polar Electro Oy) and Borg Scale (0-10). The lactate was assessed by blood sample with Pro Test Kit. To prevent different thermal responses, all subjects used the same type of lycra cap; The body composition was controlled by Tanita BF500. For the land test one treadmill and the same gas analyzer was used. The water temperature in the indoor pool was according to Aquatic Exercise Association guidelines, 28- 30°C, the air temperature was around 27°C and the humidity 50-60%. Water level was adjusted for xifoid appendices using the pool bottom elevator.

## Tests

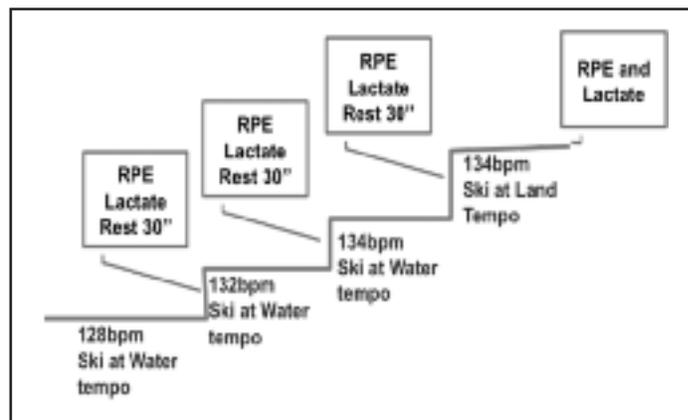
For controlling the aquatic results, all subjects performed one progressive maximal test until exhaustion with the same gas analyser on a treadmill. The land test protocol had 4' to warm up (6 km/h; 0%

grade) followed by stages with 1minute each (increasing 1km/h per min at a 2% fixed grade).

The aquatic tests were performed by each subject on separated days always in the morning. Before all tests water temperature, air temperature and humidity were registered to assure the conditions were similar. The pilot test of the aquatic protocol was confirmed 3 times. Blood sample for lactate assessment was collected at rest, after each aquatic progressive test stage and immediately after each set.

## Protocol 1

To understand the influence of exercise cadence and music tempo, each subject performed one progressive aquatic test for the Cross Country Ski pattern. The test began with 3' of warm up at 128bpm with a relaxed Cross Country Ski at Water tempo, followed by for 4 stages (3'30" each) with the same pattern. After the warm-up, the music tempo for each stage was 130bpm, 132bpm, 134bpm respectively and the last stage was performed with 134bpm at "land tempo" exercise cadence. Range of motion, body alignment and rhythm was supervised by an external viewer.



## Protocol 2

After data analyses of phase one, the 132 counts at water tempo was chosen to compare the acute responses between the aquatic patterns: Cross Country Ski Level 1 and Jumping Jack Level1(arms performed at horizontal plane). Patterns were performed with the maximal range of motion and a correct alignment according Aquatic Exercise Association Guidelines (AEA, 2009).

The protocol included one set for each pattern: 3' of warm up with Cross Country Ski at water tempo (128bpm) followed by 3'30" of the

exercise pattern, water tempo with a 132 bpm music count. No equipment added.

## Statistical Procedures

The normality of the distribution was assessed with the Shapiro-Wilk test. Paired t-test was used to compare the responses between the two aquatic exercise patterns. Linear regression models were used to describe the relationships between musical cadence and all variables of this study.

## Results

The music tempo and exercise cadence showed influence on oxygen consumption. When music cadence was 134bpm and exercise performed at land tempo (no equipment added), we observed a tendency of stabilization/reduction of  $VO_2$  consumption and an increase of lactate values. It is suggested that to follow the cadence's speed, subjects reduced the range of motion (ROM) and increase the muscular stress.

**1.1 Table.** Oxygen consumption, lactate and perceived effort (Borg 0-10) for each stage for cross country sky in different music and exercise cadence

Ski at Water Tempo	$VO_2$ (ml/min/Kg)	Lactate (mmol/ml)	RPE
128bpm	26,3±8	2,3±1	5
132bpm	28,2±8*	2,9±2	7
134bpm	29,9±8**	3,7±2	8
134bpm Land tempo	29,9±8	7,3±2	9

\*p<0,05 when compared with Ski at 128bpm

\*\*p<0,05 when compared with Ski at 132bpm

Comparing with the land test, the  $VO_2$  for Jumping was 53,42% and for Cross Country Ski was 64,13%. The relative  $VO_2$  for both patterns was  $23,27±6,4$ ml/min/Kg and  $28,18±8,4$ ml/min/Kg, respectively (p=0,017). Lactate was  $3,6±1,5$  and  $2,9±1,9$ , respectively (p=0,003).

## Conclusion

For exercise prescription, Jumping Jack seems to provide less energetic cost than Cross Country Ski. Jumping Jack showed the lowest  $VO_2$  and according to exercise program goals, the music and exercise cadence must be adapted. Young adults with good aquatic ability levels can reach higher oxygen consumption using 132-134bpm water tempo than with 128bpm; higher cadence than 134bpm (water tempo) seems to compromise the ROM and consequently reduce the oxygen consumption; 134bpm land tempo showed highest lactate accumulation, being a very intense exercise with a bigger anaerobic component. This study was supported by Aquatic Exercise Association (FL).

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## **Effect of aquatic training in adolescent's body composition.**

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Adolescence is a decisive period, because at this stage several transformations occur: hormonal, physical and psychological. Physical training is recommended. Aquatic training is a viable option and may influence body composition. The purpose of this research was to analyze the effects of an aquatic training program on body composition in adolescents. The study lasted 12 weeks, 4 times/ week, for 50 min-

utes each session. 50 adolescents of the Santos schools participated in the experiment. Monthly assessments of body composition were conducted. At the end of the experiment it was found that the Aquatic training group had significant reductions in the percentage of fat mass and increases in lean tissue mass.

# Head-out aquatic exercise “sailer’s jigs” kinematics at increasing musical cadence.

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The aim of this study was to analyze the relationships between “Sailor’s jigs” kinematics and increasing music cadence. Six young women, non-pregnant, with at least one year of experience conducting this type of head-out aquatic program, with no kind of skeletal muscle injury reported in the last six months were evaluated. The exercise was recorded on video, in the frontal plane, using a pair of cameras, enabling a double projection, from above and underwater body motions, at five increasing cadences (120 b.min<sup>-1</sup>, 135 b.min<sup>-1</sup>, 150 b.min<sup>-1</sup>, 165 b.min<sup>-1</sup> and 180 b.min<sup>-1</sup>). Images were thereafter digitized in specific software (Ariel Performance Analysis Systems). The cycle period decreased through the incremental protocol. Cycle period decrease is done decreasing joint range of motion and increasing the limbs segmental velocity as well. Although these combined kinematical strategy, a deeper analysis reveals that subjects decrease the cycle period mainly decreasing the range of motion.

## Introduction

Head-out aquatic classes are often full with dozens of subjects, giving instructors a greater challenge to maintain synchronization. Instructors use music cadence on a regular basis for such purpose. Added to that, music’s melody and cadence are a way to motivate subjects, achieving a given intensity of exertion (Kinder and See, 1992).

Basic head-out aquatic exercises are categorized in six main groups (Sanders, 2000): (i) walking; (ii) running; (iii) rocking; (iv) kicking; (v) jumping and; (vi) scissors. Some researchers analyzed the relationships between musical cadence and some of those basic head-out aquatic exercises (e.g., Oliveira et al., 2010; in press). However, it seems none of them focused on the “sailor’s jigs” exercise.

The aim of this study was to analyze the relationships between “sailor’s jigs” kinematics and increasing music cadence. It was hypothesized that increasing musical cadence will decrease the cycle period and, therefore, the segmental range of motion.

## Methods

**Subjects:** Six young women, non-pregnant, clinically healthy and physically active, holding a graduate degree in Sports Sciences and with at least one year of experience conducting head-out aquatic classes, volunteered to participate in this study (23.50 ± 3.51 years-old; 57.17 ± 4.07 kg of body mass; 1.66 ± 0.06 m of height; 20.60 ± 0.55 kg/m<sup>2</sup> of body mass index; 270.00 ± 80.50 minutes of aquatic fitness classes per week). Subjects reported no previous history of orthopedic or muscle-skeletal injuries in the previous six months. All procedures were in accordance with the Declaration of Helsinki with respect to human research. The Institutional Review Board of the

Polytechnic Institute of Bragança approved the study design. Women were informed of the experimental risks and signed an informed consent document before the investigation.

## Procedures

Each subject performed a basic head-out aquatic exercise named “sailor’s jigs”. The exercise was performed using “water tempo” according to the standard recommendations from the technical literature (Kinder and See, 1992) that was already reported in some scientific papers as well (e.g., Barbosa et al., 2010a).

The protocol consisted of five sets of 16 full repetitions of the “Sailor’s jigs” exercise, at “water tempo”, immersed to the xiphoid process (i.e., breast). The intensities of the bouts were 80 [%], 90 [%], 100 [%], 110 [%] and 120 [%] of the cadence reported by Barbosa et al. (2010a) to achieve a 4 [mmol.l<sup>-1</sup>] of blood lactate, representing 120 [b.min<sup>-1</sup>], 135 [b.min<sup>-1</sup>], 150 [b.min<sup>-1</sup>], 165 [b.min<sup>-1</sup>] and 180 [b.min<sup>-1</sup>], respectively. The musical cadence was electronically controlled by a metronome (Korg, MA-30, Tokyo, Japan) connected to a sound system. Whenever necessary, the evaluators gave verbal and/or visual cues for subjects to follow the appropriate exercise cadence and accomplish the number of repetitions asked. All subjects completed the protocol’s five bouts. The water temperature was 30°C and the relative humidity was 75 [%].

## Data Collection

The protocol was videotaped independently in the frontal plane with a pair of cameras providing a dual projection from both underwater (GR-SXM25 SVHS, JVC, Yokoama, Japan) and above (GR-SX1 SVHS, JVC, Yokoama, Japan) the water surface as reported elsewhere (Oliveira et al., 2010; in press). The study included kinematical analysis of the full exercise cycle (Ariel Performance Analysis System, Ariel Dynamics Inc., USA) through a VCR (Panasonic, AG 7355, Japan) with a sampling rate of 50 [Hz]. Zatsiorsky’s model adapted by de Leva (1996) was used, dividing the trunk in two articulated segments and including an overall number of nineteen body landmarks to be digitized in each frame. To create a single image of dual projection, as described previously (Barbosa et al., 2010b) the independent digitalization from both cameras was reconstructed with the help of a calibration object (1.50 x 0.85 m; 6 control points) and a 2D-DLT algorithm (Abdel-Aziz and Karara, 1971). For the analysis of the curve of the center of mass kinematics, a filter with a 5 [Hz] cut-off frequency was used and for the segmental kinematics 9 [Hz] was used. A double-passage filtering for the signal processing was performed. Assessed were the: (i) cycle period (P; s); (ii) range of motion ( $\Delta\phi$ , °) of the thigh-trunk, lower leg-thigh, upper arm-arm from left and

right sides and; angular velocity ( $\omega$ , °/s) thigh-trunk, lower leg-thigh, upper arm-arm from both sides.

### Statistical Procedures

The normality of the distribution was assessed with the Shapiro-Wilk test. For descriptive analysis, mean plus one standard deviation were computed as central tendency and dispersion measures, respectively. For each relationship, the mathematical model with the best good-of-fit adjustment and the lowest standard error of estimation was adopted. All relationships presented a better adjustment when linear regressions were computed. So, linear regression models were used to describe the relationships between musical cadence and selected kinematical variables, as well as, its coefficients of determination. As rule of thumb, for qualitative and effect size assessments, it was defined that the relationship was: (i) very weak if  $R^2 < 0.04$ ; weak if  $0.04 \leq R^2 < 0.16$ ; moderate if  $0.16 \leq R^2 < 0.49$ ; high if  $0.49 \leq R^2 < 0.81$  and; very high of  $0.81 \leq R^2 < 1.0$ . The level of statistical significance was set at  $P \leq 0.05$ .

### Results and Discussion

There was a significant, negative and very high relationship between P and musical cadence ( $R^2 = 0.77$ ;  $P < 0.01$ ). This means that increasing cadences imposed a decrease in the absolute duration of a full exercise. Decreasing time to perform a full exercise can be obtained: (i) decreasing the joint's  $\Delta\phi$  and maintaining the  $\omega$  or; (ii) maintaining the joint's  $\Delta\phi$  and increasing the  $\omega$  or; (iii) combining both. So, it is useful to assess both angular displacements and velocities for upper and lower limbs, in order to make it clear.

There was a decrease in the  $\Delta\phi$  (e.g., right side thigh-leg:  $R^2 = 0.286$ ;  $P = 0.002$ ; left side thigh-leg:  $R^2 = 0.141$ ;  $P = 0.041$ ; left side upper arm-arm:  $R^2 = 0.135$ ;  $P = 0.046$ ) with increasing musical cadences. In the same way there was a trend for the increase of the  $\omega$  with increasing musical cadence but with no statistical meaning for most selected variables, except for the right side thigh-trunk ( $R^2 = 0.133$ ;  $P = 0.047$ ). So, decreasing the cycle period is achieved through a combination of decreasing the  $\Delta\phi$  and increasing the  $\omega$ . Although the combined kinematical strategy, a partial comparison to analyze the most determinant behavior (i.e., if the decrease of  $\Delta\phi$  or the increase

in the  $\omega$ ) reveals that subjects decrease the cycle period mainly decreasing joint range of motion.

### Conclusion

The increase of musical cadence imposed a decrease of the cycle period and; the cycle period changed the limb's kinematics, mainly imposing a  $\Delta\phi$  decrease. As practical implication, instructors should choose musical cadences according to subject's fitness level, avoiding cadences that impose a significant decrease of the full  $\Delta\phi$ . Plus, they should always give verbal and/or visual cues for subjects to perform the exercises through full range of motion, following the selected exercise cadence.

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# Effects of a 26-week shallow water head-out aquatic exercise program on the anthropometrics, body composition, and physiological response of healthy middle-aged women.

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The aim of this study was to assess the chronic adaptations (anthropometrics, body composition, physiologic) of the middle-aged women participating in a head-out aquatic exercise program for 26 weeks. Twenty-three healthy middle-age female subjects participated in a head-out aquatic exercise program (26 weeks, two sessions per week, and 40 minutes per session). Data was collected before starting the program (pre-test), at the 13th week (post-test 1) and at the 26th week (post-test 2). Anthropometrical data included body mass, body mass index and several anatomical perimeters. Body composition was assessed measuring several body skinfolds. Physiological measures included the resting heart rate, systolic, diastolic and mean blood pressures. The body mass and the body mass index presented non-significant improvements throughout the program. On the other hand, subjects improved their body composition, decreasing fat mass. Main improvements happened in the first 13 weeks, since most variables did not present significant improvements between the post-test 1 and post-test 2. As a conclusion, a head-out aquatic exercise program with 26 weeks promotes a significant improvement in the anthropometrics, body composition and physiological response of healthy middle-age women.

## Introduction

Research about head-out aquatic exercise can focus on acute or chronic responses. Chronic adaptations represent the accumulation of acute responses during each aquatic session. To promote these cumulative effects of acute responses over time, the use of appropriate means and methods of work during the sessions (i.e., mode or type of exercise, frequency of participation, duration of each exercise bout, and intensity of the exercise bout) are warranted (Barbosa et al., 2009). Aerobic capacity, body composition, flexibility, muscular strength and endurance are monitored on a regular basis to assess chronic adaptations (Wilmore & Costill, 1994).

One trend of research regarding this topic is the effect of a head-out aquatic exercise program in elderly subjects with an injury or pathology and even physically challenged. However, a small quantity of research is done with middle-aged healthy women, although they are a large part of the persons participating in head-out aquatic exercise sessions.

The aim of this study was to assess the chronic adaptations (anthropometrics, body composition, physiologic) of middle-aged women participating in a head-out aquatic exercise program during 26 weeks. It was hypothesized there would be a significant improvement in the anthropometrics, body composition and physiological response throughout the exercise program.

## Methods

**Subjects:** Twenty-three middle-age women ( $47.6 \pm 10.1$  years-old;  $160.4 \pm 1.7$  cm of body height) participated in the head-out aquatic exercise program. None of the subjects were involved in any other fitness program during the research. Subjects were asked to maintain their daily routines. Subjects reported no previous history of orthopedic or muscle-skeletal injuries in the previous six months. All procedures were in accordance with the Declaration of Helsinki with respect to human research. The Institutional Review Board of the Polytechnic Institute of Bragança approved the study design. Women were informed of the experimental risks and signed an informed consent document before the investigation.

**Head-out aquatic exercise program:** The head-out aquatic exercise program had 26 weeks and followed the main Aquatic Exercise Association guidelines (Aquatic Exercise Association, 2008). The program included two sessions per week, with 40 minutes of duration each. All sessions were conducted in a shallow water swimming pool, immersed to the xiphoid process. Music cadence ranged between approximately 125-150 bpm and exercises were cued to be most of the time performed at water tempo. In some sessions, rubber bands, buoyancy and drag equipment were used. Sessions were structured taking into account the technical literature (Kinder and See, 1992) starting with a warm-up (5 minutes), followed by cardio-respiratory conditioning (20 minutes), muscle strength conditioning (10 minutes) and, stretches and/or cool down (5 minutes). Subjects participated in  $80.1 \pm 10.1$  % of the sessions.

## Data Collection

Data was collected before starting the program (pre-test), at the 13th week (post-test 1) and at the 26th week (post-test 2). Anthropometrical data included the measurement of the body mass (BM) in the upright position with a digital scale (SECA, 884, Germany). Body mass index (BMI) was computed as  $BMI = \text{body mass}/\text{height}^2$ . The chest, waist, hip, lower leg and brachial perimeters were measured with a flexible anthropometrical tape (RossCraft, Canada). For body composition assessment, a skinfold caliper (Harpندن, RossCraft, Canada) was used to measure the triceps, subscapular, abdominal, germinal skinfolds and the sum of the triceps plus the subscapular skinfolds with the subjects in the specific anatomical position. Physiological measures included the resting heart rate (HRr), systolic (SBP) and diastolic blood pressure (DBP) (M4-I, Omron, Netherlands) with the subjects in a seated position. Mean blood pressure was calculated as  $MBP = DBP + [0.333 \times (SBP - DBP)]$  (Wilmore & Costill, 1994).

## Statistical Procedures

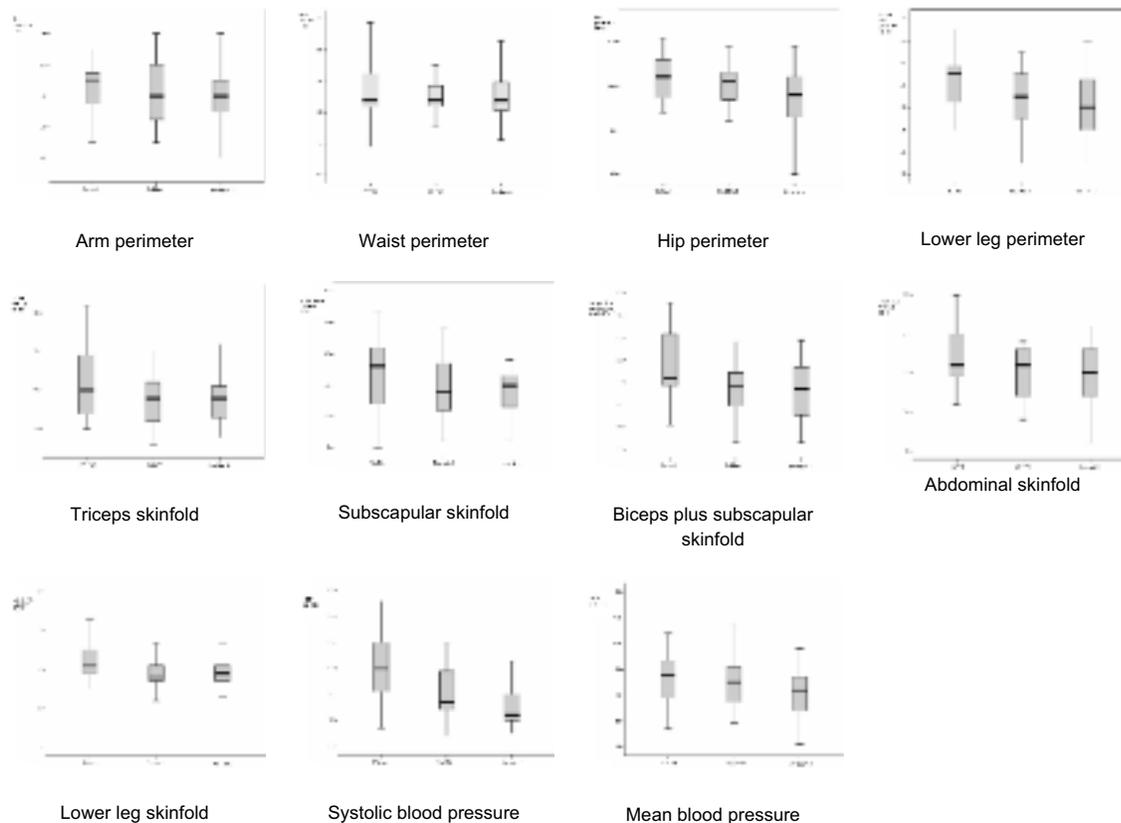
The normality of the distributions was assessed with the Shapiro-Wilk test. For descriptive analysis, box plots, including quartiles, were performed. Non-parametric Friedman test was used to compare each variable throughout the exercise program. Whenever a significant difference was verified, Pairwise Wilcoxon Rank Sum Tests were used to identify between each moment those differences happened. The level of statistical significance was set at  $P \leq 0.05$ .

## Results and Discussion

Figure 1 presents a box plot of variables with significant changes. Significant differences were verified throughout the three evaluation moments in: (i) the brachial perimeter ( $X^2(2) = 7.811$ ;  $p = 0.02$ ) with significant decrease from pre-test to post-test 1 ( $p = 0.03$ ) and post-test 2 ( $p = 0.01$ ); (ii) waist perimeter ( $X^2(2) = 7.634$ ;  $p = 0.02$ ) with significant decreases from pre-test to post-test 1 ( $p = 0.05$ ); (iii) hip perimeter ( $X^2(2) = 15.367$ ;  $p < 0.001$ ) with significant decrease between all evaluation moments; (iv) lower leg perimeter ( $X^2(2) = 24.641$ ;  $p < 0.001$ ) with significant decrease between all evaluation moments; (v) triceps skinfold ( $X^2(2) = 9.566$ ;  $p < 0.01$ ) with significant decrease between pre-test and post-test 1 ( $p < 0.001$ ) and post-

test 2 ( $p < 0.01$ ); (vi) subscapular skinfold ( $X^2(2) = 10.541$ ;  $p < 0.01$ ) with significant decrease between pre-test and post-test 1 ( $p < 0.01$ ) and post-test 2 ( $p < 0.01$ ); (vii) abdominal skinfold ( $X^2(2) = 13.390$ ;  $p < 0.01$ ) with significant decrease between pre-test and post-test 1 ( $p < 0.01$ ) and post-test 2 ( $p < 0.01$ ); (viii) lower leg skinfold ( $X^2(2) = 6.100$ ;  $p = 0.05$ ) with significant decrease between pre-test and post-test 1 ( $p = 0.01$ ) and post-test 2 ( $p = 0.04$ ); (ix) the sum of triceps with subscapular skinfold ( $X^2(2) = 18.396$ ;  $p < 0.001$ ) with significant decrease between pre-test and post-test 1 ( $p < 0.001$ ) and post-test 2 ( $p < 0.001$ ); (x) the SBP ( $X^2(2) = 8.000$ ;  $p = 0.02$ ) with significant decrease between pre-test and post-test 1 ( $p = 0.01$ ) and post-test 2 ( $p < 0.01$ ) and; (xi) MBP ( $X^2(2) = 12.568$ ;  $p < 0.01$ ) with significant decrease between pre-test and post-test 2 ( $p = 0.04$ ) and between post-test 1 and post-test 2 ( $p = 0.01$ ). Remaining variables did not present significant improvements.

Comparing data between the pre-test and the post-test 2 there was a significant improvement in body composition. However, main improvements happened in the first 13 weeks, since most variables did not present significant improvements between post-test 1 and post-test 2.



**Figure 1.** Quartiles of the variables with significant improvements throughout the program.

Main anthropometrical variables selected (i.e., BM and BMI) presented non-significant improvements. On the other hand, subjects decreased slightly most of the anatomical perimeters but, mainly the skinfolds assessed. So, a non-significant change in the BM and BMI associated to a main decrease in the fat mass can be related to an increase of the lean mass, mainly of the muscle mass. Muscle mass was not considered in this manuscript. However, it should be included in future research. In the same way, the understanding of the co-variation between physical activity and food in-take should also be considered.

The SBP and the MBP presented significant improvements throughout the 26 weeks. In this sense, a half-year head-out aquatic exercise program has a significant effect in improving the cardio-vascular response of healthy middle-age women. Earlier observations have already suggested these exercise programs for subjects with a high blood pressure condition (Aoba, Hamai & Nomura, 2008).

### Conclusions

As a conclusion, a head-out aquatic exercise program for 26 weeks promotes significant improvements in anthropometrics, body composition and physiological response of healthy middle-age women.

Such improvements happened mainly in the first 13 weeks of the program. As a practical implication, instructors should design and conduct head-out aquatic exercise programs according to Aquatic Exercise Association guidelines for at least 13 to 26 weeks to promote significant body composition and physiological changes in middle-age women.

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# Behavior of heart rate and perception of exertion in women during a 12-minute running test in a shallow pool: pilot study.

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## Introduction

Running in water means adapting the gestures of street running by traveling with your feet at the bottom of the pool, besides increasing overload using appropriate equipment (Kanitz et al, 2010). The benefits are: improvement or maintenance of general fitness, aid in joint rehabilitation, cross training, and lower joint stress (Haupenthal et al, 2010). For better performance a shallow pool is recommended, though the intensity control through physiological responses and perceived exertion during collective activities in gyms would contribute to a better prescription.

## Objective

The purpose of this study is to compare the behavior of heart rate (HR) and perceived exertion (PE) in women who practice aquarunning and women who practice outdoor running in the 12 minute run test in shallow water.

## Material and Methods

Six volunteers took part in the study: three of them practice aquarunning (age:  $46.00 \pm 9.54$  years, height:  $1.58 \pm 0.02$  m and body mass:  $56.63 \pm 7.26$  kg) and three of them practice outdoor running (age:  $34.7 \pm 3.06$  years, height:  $1.66 \pm 0.06$  m and body mass:  $61.50 \pm 5.26$  kg). The study was limited to women who did not use medications that could alter their HR. The test was performed in a 20m long, 6m wide, and 1.35m deep pool. The volunteers followed the protocol with the water at their xiphoid process. The water temperature ranged from  $30.5^\circ$  C to  $31.0^\circ$  C. The relative humidity of the air was 50%. Before going into the pool, their total body mass and total height were checked (Filizola® PL150-Line Personal, Brazil) and all the volunteers were wearing comfortable swimsuits for physical activity in water. Proper tennis shoes for water were not used and all participants were tested barefoot. Soon after, they were all informed about the standardization of the movements. Performing the running test with the arms out of the water or pushing the edges with the hands or feet was not allowed. The participants could only touch the edges with one hand and return to the other edge at the same depth (Silva and Neto, 2006). The HR was measured every minute with

the frequency meter (Polar®, A1, Finland) and PE was checked (Borg Scale-CR10) every three minutes. The running movements were standardized, so that the knees did not exceed the line of the hip and the trunk was slightly inclined to the front. The arms were submerged and were moved simultaneously and perpendicular to the trunk (similar to the stroke in the breaststroke style). A warm-up lap was performed with the movements that would be used later. The indication of intensity for this lap was established as weak (2), according to PE (Borg Scale-CR10). After this lap, the marking of the 12 minutes of continuous running at top speed was begun.

## Results

For the comparison of behavior of HR during 12 minutes considering the specificity of the activity of the practitioner, the two way test (repeated measures) was used. A post-hoc Bonferroni test was used to describe possible differences among the variables. On this, no significant differences were found ( $F=0.23$ ;  $p=0.99$ ) on the behavior of HR between women who practice aquarunning ( $140.42 \pm 15.55$  bpm) and who practice outdoor running ( $145.50 \pm 14.98$  bpm). The variable PE was compared through Mann-Whitney test ( $Z= 0.89$ ;  $p=0.37$ ) and no significant differences were found on the third ( $5.00 \pm 26.64\%$ ;  $2.00 \pm 24.74\%$ ), sixth ( $5.00 \pm 24.35\%$ ;  $2.50 \pm 20.00\%$ ), ninth ( $6.00 \pm 16.66\%$ ;  $3.00 \pm 10.18\%$ ) and twelfth ( $7.00 \pm 27.15\%$ ;  $5.00 \pm 34.64\%$ ) minutes between women who practice aquarunning and who practice outdoor running respectively. The data were processed using Statistical software (Statsoft, version 6.0, USA). All data intervals are presented as mean  $\pm$  standard deviation (SD). PE are presented as medians and percentage of coefficient of variation. The study admitted a significance level  $p=0.05$ .

## Conclusion

No significant differences were found, however new studies are recommended with more participants, as well as with different gender, ages and conditioning level.

**Keywords:** aquarunning; aquatic exercises; outdoor

**Facility:** Aquatic area of Velox Fitness Center in Rio de Janeiro

# The acute effect of stretching according to the proprioceptive neuromuscular facilitation method (PNF) in front crawl speed.

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## Introduction

Throughout history the use of muscle stretching has always been included in the status of a beneficial preventer of injuries and to enhance physical performance. However scientific research, especially in the twenty-first century, suggests that stretching is harmful to athletic performance and it does not reduce the risk of injury. But nowadays athletes who stretch prior to participating in different sports competitions have been observed.

## Objective

To investigate the acute effect of stretching by the method of proprioceptive neuromuscular facilitation (PNF) on the performance of frontal crawl.

## Method

Five male subjects (age:  $22 \pm 3$  years) have performed two maximal tests of 50 meter front crawl. There was no previous procedure in one of the tests and the other (48 hours later) was proceeded with PNF stretching for muscles of the quadriceps and body. For no influence at the exit, the individuals left in ventral decubitus, where they were supported by another individual and remained with their feet 2cm apart from the edge, so they would not push the wall.

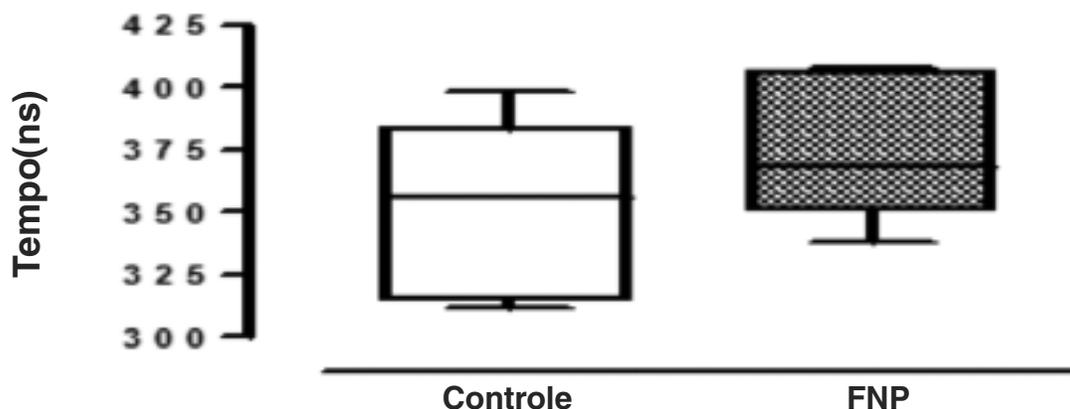
## Results

To obtain the results a one-way ANOVA with Tukey post hoc significance and  $p \leq 0.05$  was performed. After paired comparisons by Tukey test, there were no significant differences between groups ( $p = 0.46$ ). [Control (30'12", 33'68", 30'68", 30'56", 31'07") Vs FNP (32'43", 36'54", 31'28", 30'68", 33'78")].

## Conclusion

Considering that in swimming, fractions of seconds can decide competitions, which cannot be considered significant by statistics, IT may be crucial in practice. Thus, concerning the limits imposed by the method and small sample group, this study concludes in part that PNF stretching, acutely, could cause deficit in the performance of front crawl.

**Keywords:** Swimming, flexibility and performance



(Figure 1) Acute effect of PNF method on the performance of front crawl ( $p \leq 0.005$ ).

# The profile of members of a physical activity program for pregnant women in the southern area of Rio de Janeiro / Brazil.

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## Introduction

Concerns of pregnancy evolution and delivery as a consequence of the lifestyle of women has been the subject of numerous recent scientific discussions (R Artal and M O'Toole, 2003). Today, women are looking for physical activity as a healthy lifestyle (Hegaard et al, 2010). Many are physically active before pregnancy and others are encouraged to be physically active when they find out they are pregnant as a way of habit changing (Baciuk et al, 2008). Last year (November 2010), in the southern area of Rio de Janeiro, a specific program of physical activity for pregnant women started at Bella Gestante Space. In order to take part in this program subjects had to fill out a questionnaire about their life style and their health.

## Objective

The aim of this study was to identify the profile of the pregnant women who were about to start a specific program of physical activity.

## Methods

63 questionnaires were analyzed at different gestational ages. It was necessary to be 12 weeks pregnant with no health restrictions to participate in the program. Descriptive statistics applying the frequency table were used.

## Conclusion

Observation of these questionnaires is very useful for understanding this special group and how to work with them emotionally and physically.

## Results Summary

- Allergies presented were: rhinitis (20.63%), asthma (1.58%) and others (34.92%). However, most of the group did not report any type of allergy (57.14%).
- The group reported using some drugs. Those with the highest frequency were: vitamins (68.25%), iron (12.69%), folic acid

(17.46%) and others (11.11%). However, some subjects did not use any kind of medication (15.87%).

- The group reported on the number of pregnancies they had experienced. The majority reported one pregnancy (49.20%), and then the next highest frequency was two pregnancies (34.92%). Only one of the volunteers demonstrated to have had four, five or seven pregnancies (1.58%), respectively.
- The goals set by the volunteers in the practice of regular physical exercise were: wellness (68.00%), control of body weight (30.15%), delivery preparation (11.11%) and physical fitness (4.76%). The frequency of one was observed for the variables of balance and circulation (1.59%).
- The group of volunteers reported that most of them practiced physical exercises (77.77%) and only 22.22% did not practice any type of exercise prior to the program.
- The most frequent type of delivery was cesarean section (23.80%) and only 3.17% performed vaginal delivery.

**Keywords:** pregnancy; aquatic exercises; fitness assessment

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# Hydro bike training for triathletes; study of cardio-respiratory and metabolic adaptation during incremental hydro bike exercises.

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## Objective

Scope of the research was to check the validity of hydro bike training as an alternative method to improve Triathletes' performance, by studying cardio-metabolic adaptations.

## Materials and Methods

9 male, FITRI (Italian Triathlon Federation) enrolled, Master category athletes (age 39.2 ± 13.2 years, weight 73,5 ± 4.5 kg and height 178 ± 9 cms) who regularly take part in Regional, National and International competitions accepted to adhere the protocol. The first step provided for an incremental test to exhaustion using Hydro bikes (Hydrorider Professional- Italy) with 2 minute incremental pedalling frequency (RPM). Athletes wore a metabolism meter (VO2000, MedicGraphics, US) during the test and maximum oxygen consumption (VO<sub>2max</sub>), maximum heart rhythm (HRmax) and anaerobic threshold (AT) were constantly monitored. Subsequently they attended 12 Aqua Cycling sessions (single session 40 min, frequency 3 times/week – 1 month) following an Interval Training 4':3'x 4 (ref. bibliographic 1-2) type protocol. During the protocol period the athlete did not have any competitions and they reduced normal triathlon training; after the research protocol the athletes repeated the incremental test to exhaustion using the same materials and methods indicated above.

## Results

Statistical analysis of the data showed that the VO<sub>2max</sub>, HR and AT parameters had not changed significantly but had maintained previous values even after the Aqua Cycling training sessions.

## Debate

The results of this study show that the Hydro bike training protocol applied was useful in enhancing and maintaining cardio-metabolic parameters for triathletes, even during reduced competition periods, and that it can be considered as a valid alternative training practice having a reduced mechanical stress effective in contrasting some detraining effects (ref. bibliographic 3).

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# Depth jumps on land and in water: a kinetic comparison.

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## Introduction

Plyometric training is used to develop explosive speed, strength and power<sup>1</sup>. Exercises may include single or repeated effort hops, bounds or shock drills performed on one or both limbs. Depth jumps are one of the most commonly used exercises<sup>7</sup>; they require an athlete to step off a box without any upward movement, land on the ground then immediately perform a vertical jump for maximum height while minimising ground contact time<sup>8</sup>. They place high stretch loads on the leg extensors and involve fast stretch-shortening cycle activity and explosive, muscle contraction<sup>8</sup>. Consequently, they are associated with high impact forces on landing.

Water resistance and buoyancy reduce landing forces during a range of aquatic plyometric exercises<sup>2, 3, 6</sup> while increased propulsive forces have been found for aquatic squat jumps<sup>2, 6</sup>. Contact times during a depth jump may also be altered in water, however this has not yet been examined. Changing contact time can alter how a jump is carried out, which allows specific performance parameters to be targeted and can have implications for specificity of training<sup>7</sup>. Therefore, the aim of this study was to compare the propulsive kinetics, landing kinetics and contact times of depth jumps performed on land and in water.

## Methods

Ethical approval was obtained from the institutional ethics committee and 18 male swimmers (age,  $23 \pm 1.9$  years; height,  $1.76 \pm 0.06$  m; weight,  $71.7 \pm 6.9$  kg; percent body fat,  $20.8 \pm 2.5$  %) provided written informed consent to take part in the study. All participants wore swimming shorts and aqua shoes (Rykä Hydro Step) during testing. After a warm-up, they performed a depth jump from a box of height 30 cm and landed on a force plate (Kistler 9253B11, Switzerland) operating at 2000 Hz. Participants were instructed to keep hands on hips and jump for maximum height. This procedure was repeated in water at a depth of 1.30 m where participants landed on a portable underwater force plate (Kistler 9865E1Y28, Switzerland).

In a depth jump, the first contact phase in the force-time trace occurs after stepping off the box and the second contact phase occurs when landing after the jump. During the first contact, peak propulsive force (normalised to body weight, BW), propulsive impulse and normalised propulsive rate of force development (RFD) were calculated. During the second contact, peak landing force, landing impulse and landing RFD were obtained. Impulses were calculated by integration of the force-time curve. Contact time was the duration of the first contact phase.

Statistical analysis used SPSS (PASW) Statistics v17 (2009). A repeated measures ANOVA was used to compare each measure in land and water conditions. Significance level was set at  $p < 0.05$ . Cohen's *d* effect sizes were calculated using the formula: Effect size =  $(\mu_1 - \mu_2) / SD_{\text{pooled}}$ , where  $\mu_1$  and  $\mu_2$  represent the means in each condition and the  $SD_{\text{pooled}}$  was calculated as  $\sqrt{[(SD_1^2 + SD_2^2)/2]}$ . Interpretation of effect sizes was based on Hopkins<sup>4</sup>, where 0.2, 0.6, 1.2 and  $>2.0$  represented small, medium, large and very large effect sizes respectively.

## Results

Peak force, impulse and RFD during the propulsive phase were significantly reduced in water compared to on land ( $p < 0.05$ ), see Table 1. A very large effect size accompanied this 46% reduction in force, however lower reductions and small-medium effect sizes were seen for impulse and RFD. Landing kinetics were significantly reduced in water ( $p < 0.05$ ) with reductions reaching 14-36%. Again, effect sizes were very large for force but small-medium for other measures. Contact time increased by 37% when jumping in water ( $p < 0.05$ , large effect size).

## Discussion

Reduced landing kinetics during depth jumps in water were expected based on the effects of buoyancy and water resistance and this supports previous research<sup>2, 3, 6</sup>. A 36% reduction in peak landing forces is substantial and it is speculated that this reduced joint loading may help to reduce the risk of injury, however further prospective intervention based studies are required to examine this. Kinetic measures obtained during propulsion were also reduced in water which disagrees with previous research on squat jumps<sup>2, 6</sup>, however this may be due to the different exercises analysed.

Schmidtbleicher (1992) proposed that contact times less than 250 ms represent fast stretch shortening cycle (SSC) activity while contact times exceeding this indicate slow SSC activity<sup>5</sup>. Mean contact time for depth jumps on land was 240 ms with the majority of participants demonstrating fast SSC activity. Jump height increases with reduced contact time (to a certain level) which has implications for training<sup>7</sup> and makes depth jumps very specific for activities that require fast contact times and fast SSC activity. As contact times for aquatic depth jumps are above 250 ms for all but 3 participants, this suggests that they are slow SSC activities and therefore, would provide a different training stimulus.

**Table 1.** Kinetics during a drop jump on land and in water.

	<b>Land (Mean ± SD)</b>	<b>Water (Mean ± SD)</b>	<b>Effect size</b>	<b>% difference</b>
Propulsive force (BW)	5.74 ± 1.47	2.86 ± 0.48 *	d=2.63	↓ 46
Propulsive RFD (BW.s <sup>-1</sup> )	109 ± 102	43 ± 51*	d=0.41	↓ 22
Propulsive impulse (N.s)	312 ± 28	244 ± 49 *	d=0.62	↓ 9
Contact time (ms)	240 ± 70	310 ± 60 *	d=-1.17	↑ 37
Landing force (BW)	6.57 ± 1.40	4.05 ± 1.02 *	d=2.06	↓ 36
Landing RFD (BW.s <sup>-1</sup> )	120 ± 43	96 ± 43 *	d=0.58	↓ 30
Landing impulse (N.s)	195 ± 24	134 ± 24 *	d=0.61	↓ 14

SD, standard deviation

\* indicates significant difference between land and water conditions (p<0.05)

## Conclusion

Water provides a less stressful environment for depth jumps to take place in as evidenced by reduced kinetic loading during landings. However, propulsive forces are reduced and contact times are longer suggesting that jump height may also be reduced. Coaches who want to include aquatic depth jumps in their training programmes should be aware that they may not develop explosive, fast stretch shortening cycle activity which has implications for specificity of training for particular sports.

## Acknowledgements

The project was funded by the Carnegie Trust and Daiwa Anglo-Japanese Foundation. The author thanks Dr Hideki Takagi, Dr Tsuyoshi Takeda and Hirofumi Shimojo, and the MSc and PhD students in the Swimming Biomechanics group at the University of Tsukuba for their support and assistance during data collection.

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# Heart rate and oxygen saturation within and outside the aquatic environment for women.

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With the great frequency in the incidence of chronic and non-transmittable diseases there has been an increased demand for physical activity specifically in large cities (ACHUTTI, 2004). Aquatic exercises are still the most recommended and sought after physical activity by the age group most prone to the onset of these diseases and their co-morbidities. So for benefits and safety, many studies have been conducted to analyze the physiological responses of the body to the aquatic environment (ALVES, 2004).

The aim of this study was to analyze heart rate (HR) and oxygen saturation (Sat) in and out of the aquatic environment in the resting state of women practicing aquatic exercises in order to observe the effect of physical properties of water, more precisely buoyancy and hydrostatic pressure. For this, 26 women were subjected to the test outside and within the same pool, heated to 32 ° C and shoulders completely submerged after resting for 5 minutes.

## Results

The distribution of data from this study showed a normal curve for all anthropometric variables as well as physiological. The description of the sample can be observed in Table 1.

**Table 1:** Description of anthropometric characteristics of 26 elderly women

	Minimum	Maximum	Mean ± SD
Age (years)	46	93	69,69±10,57
Body weight (kg)	43,6	104,6	73,48±14,51
Height (cm)	1,46	1,80	1,615±0,09
BMI (kg/m <sup>2</sup> )	19,9	37,5	28,07±4,55

The comparison of variables in the terrestrial and aquatic environments indicated significant differences ( $p < 0.05$ ) for all variables (Table 2).

According to the results we can observe a decrease in heart rate (Table 2) explained by the action of buoyancy and hydrostatic pressure favoring an easing in venous return. (CAROMANO, 2003).

**Table 2:** Comparative results for responses of physiological parameters of 26 elderly women in the terrestrial and aquatic environments.

Minimum	Maximum	Mean±SD	t	Sig
HR T	55	85	75,77±7,34	5,312 0,001
HR A	57	83	71,27±7,04	
Sat T	94	99	97,38±1,42	5,037 0,001
Sat A	91	99	95,27±2,49	

Oxygen saturation also decreased (Table 2). The hypothesis is that both the thorax and abdomen suffer the action of hydrostatic pressure by both the compression and increasing the central volume, causing an increase of nearly 65% in respiratory work and promoting a reduction of 66% of the volume of respiratory reserve. Due to this overhead there is a significant change in pulmonary ventilation, perfusion and V/Q relationship leading to reduction in arterial oxygen, directly impacting on the oxygen saturation.

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# A comparison of land plyometric training and aquatic plyometric training with and without aquatic training gear on vertical jump performance in NCAA III football players.

Killgore, G. L., N., Fendall, G. Hill, S.C. Coste, N. Evans, S. Fennimore, H. Hasha, and J. MacInnes.

The purpose of this investigation was to identify whether the use of AQx® Aquatic Training Shoes (ATS) and a Zero Gravity Buoyancy Suit would make a significant difference in power production when compared to land based training and water based training while barefoot without any external buoyancy suit. It was hypothesized that since it has been shown that the AQx® ATS had demonstrated a statistically significant difference in deep-water running (3), that a similar outcome may be observed in shallow water plyometric training, especially when used in conjunction with a buoyancy suit. Thirty five male NCAA III football lineman were recruited for the investigation and were randomly assigned to one of three groups; 1) shallow end of the pool while barefoot (N = 11); 2) shallow end of the pool while wearing ATS and a buoyancy suit (N = 13); 3) in a gymnasium on a basketball floor (N = 13). Before starting the program, all subjects completed an IRB approved consent form, and vertical jump performance, body fat percentage ( $23.8 \pm 4.6\%$ ), height ( $72.8 \pm 2.3$  in) and weight ( $253.4 \pm 31.3$  lbs) were recorded. The subjects then completed a four week program that included identical warm-up, plyometric workout, and subsequent imbedded strength and conditioning routines, twice each week. The plyometric program was developed using the guidelines set forth for plyometric “advanced” participants by the National Strength and Conditioning Association, i.e. 140 ground contacts/session. The plyometric drills included specific exercises that are consistently used with an experienced population (1): Power Skipping, Split squat jump - lunge like, 2 x squat jumps 1 with feet shoulder width apart (hands on hips), 2 x squat jumps 2 with feet more narrow (hands on hips), double leg tuck jump – knees to chest, double leg tuck jump – heel to butt, power skipping, split squat jump – shorter faster, split squat jump – lunge like, double leg tuck jump – knees to chest, double leg tuck

jump – heel to butt, and power skipping. A researcher was present at every session to insure proper technique, safety, and participation. In addition, a certified lifeguard was on duty during the pool plyometric training. A post-test on the vertical jump was administered at the conclusion of the fourth week of the program and again after the subjects returned from a break of ten days. A repeated measures ANOVA was used to determine the statistically significant differences for power using the vertical jump. No significant differences were demonstrated between the groups after four weeks (P1) ( $p < .188$ ) or after the ten day break (P2) ( $p < .164$ ). The land group recorded pre, P1, and P2 test values of  $19.6'' \pm 3.4$ ,  $20.1'' \pm 3.3$ ,  $21.1'' \pm 3.1$  respectively. The barefoot group remained the same from the pre test to the post-test 1 ( $19.7'' \pm 4.6$ ), but improved to  $20.3'' \pm 4.1$  after the break (P2). The aquatic training gear group improved from a pre-test value of  $19.8'' \pm 3.5$  to  $20.1'' \pm 2.6$  (P1) and  $20.7 \pm 2.6$  (P2). This corroborates previous research regarding using aquatic plyometrics as a comparable alternative to land-based plyometrics (2, 4, 5, 6). Furthermore, observations and anecdotal feedback support the idea that proper footwear decreases the likelihood of slipping on the pool bottom and provides protection for the foot. In addition, although not statistically significant, wearing both the suit and shoes provided more of an increase in vertical jump performance than exercising while barefoot in the shallow water and compares more favorably with land-based results. These results lend credibility to incorporating an aquatic-based plyometric program into a comprehensive conditioning program in football linemen and populations with comparable body types.

**Keywords:** shallow-water plyometric training, land-based plyometric training, vertical jump

# A comparison of land vs. aquatic plyometric training while shod and barefoot on vertical jump performance in active college-aged women.

Killgore, G. L., S. C. Coste, S. Marroquin, and N. Skarmas.

The purpose of this investigation was to identify whether the use of AQx<sup>®</sup> aquatic training shoes (ATS) during plyometric aquatic exercise as compared to a barefoot condition would make a significant difference in the vertical jump performance of women. It was hypothesized that since it has been shown that the AQx<sup>®</sup> ATS had demonstrated a statistically significant difference in deep-water running (3), that a similar outcome may be observed in shallow water plyometric training. Twenty one female college-aged women were recruited for the investigation and were randomly assigned to one of three groups; 1) shallow end of the pool while barefoot (N = 6); 2) shallow end of the pool while wearing ATS (N = 5); 3) in a field house on a compliant surface shock absorbing surface (AstroTurf<sup>®</sup>) (N = 6). Due to attrition, only seventeen women completed the study. Before starting the program, all subjects completed an IRB approved consent form, and vertical jump performance, height and weight were recorded. The subjects then completed a five week program that included identical warm-up, plyometric workout, and cool-down routines, three times each week. The plyometric program was developed using the guidelines set forth for plyometric beginners by the National Strength and Conditioning Association, i.e. 80-100 ground contacts/session with a progression to a moderate level (up to 120 ground contacts/session) after the completion of the first three weeks of the program for the remaining two weeks for a total of five weeks. The plyometric drills included primarily double support specific exercises that are consistently used with a beginner level population (1): Split squat jump - lunge like; Squat jumps 1 with feet shoulder width apart

(hands on hips); Squat jumps 2 with feet more narrow (hands on hips); Double leg tuck jump – knees to chest; Double leg tuck jump – heel to butt; Split squat jump – shorter faster; Split squat jump – lunge like; Double leg tuck jump – knees to chest; Double leg tuck jump – heel to butt; Elevated skip.

A researcher was present at every session to insure proper technique, safety, and participation. A post-test on the vertical jump was administered at the conclusion of the program and height and weight were recorded. A repeated measures ANOVA was used to determine the statistically significant differences for power using the vertical jump. No significant differences were demonstrated between the groups ( $p < .106$ ) with the land group recording a pre and post test value of  $16.8'' \pm 2.5$  and  $18.9'' \pm 1.0$ , respectively. The barefoot group improved from  $14.8'' \pm 3.5$  to  $18.6'' \pm 4.3$  and the shod group improved from a pre-test value of  $16.5'' \pm 2.7$  to  $17.4'' \pm 2.7$ . This corroborates previous research in this area of interest regarding the efficacy of using aquatic plyometrics as a comparable alternative to land-based plyometrics (2, 4, 5, 6). Furthermore, observations and anecdotal feedback support the idea that proper footwear decreases the likelihood of slipping on the pool bottom and provides protection for the foot. Wearing the ATS may be recommended as an appropriate shoe to be worn in both shallow and deep water exercise sessions.

**Keywords:** shallow-water plyometric training, land-base plyometric training, vertical jump,

# The effect of a specialized program in water on the changes of soccer players' coordination skills.

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## Introduction

One side oriented load and early specialization in various sports causes not only early end to the sport career, but also produces conditions for plenty of injuries that are

typical for the particular sport (in soccer injuries of lower limbs and spine pain). Water creates, with its special features, an environment for active compensation of one sided physical activity in performance sport and provides for balanced load of all the organism's systems by means of special physical skills to help develop coordination. Programs in water have mostly aerobic character<sup>1,2,3,4</sup> but also the character of strength and endurance<sup>5,6</sup>.

In our research we monitored the affect of a conditioning program in water on soccer players' special coordination, which was tested on land.

## Aim

The aim of the research was to find out the effect of the conditioning program in water on changes of coordination skills of young soccer players.

## Methods

The research was realized by means of two experimental groups during 3 months. The research group involved 24 young players age 17-19 years. The experimental group (n 12) trained twice a week in water, for 45 minutes.

At the beginning and end of the research we monitored coordination skills and spine flexibility (Harre test, running to bases) by means of special soccer motor tests. We also evaluated the swimming capability by 25m freestyle and 5 min swimming.

We used for evaluation of statistical significance between experimental and control group Mann-Whitney U-test and non-parametric Wilcoxon T-test. We wanted to find the differences in the level of coordination skills at the beginning and at the end of the research.

Experimental factor – program in water was aimed at exercises with basic locomotion of lower limbs in deep and shallow water (running forwards, backwards, sideways ) with use of water features; the accuracy of exercise was monitored during stretching exercises.

All the exercises were of moderate intensity and the length of exercises was monitored (3-5 minutes). The base of the program was created by exercises with various body positions (lateral, vertical, horizontal). Every lesson included continuous swimming because of adequate use of upper limbs and the respiratory system (breathe out into water).

## Results

Some exercises used a swimming board, which is the most available tool in swimming pools in Slovakia. The upper limbs were holding the boards to create a good stable support and at the same time they were working together with the upper torso.

The lower limbs were practicing various exercises. The change of body positions stimulated new motor movements for developing coordination (fig.1).

The influence of the conditioning program in water proved clearly its effect on the changes of the players' coordination skills. Whilst in the control group we monitored a decrease of motor performance, the experimental group of condition training in the water achieved after 3 months statistically significant improvements in all tests of coordination on land.

**Tab. 1** Statistical characteristics of the experimental group

Start	Bend forward (s)	Harre Test (s)	Slalom (s)	Run (s)	Swimming	
					5 min.	25 m
average	9,33	21,14	12,40	7,538	207,1	19,80
st.deviation	5,449	1,802	0,607	0,535	28,32	1,370
median	10,0	20,89	12,31	7,57	200,0	19,79
min.	-3	18,06	11,59	6,57	175	17,64
max.	18	24,90	13,66	8,57	265	21,90
var. allowance	21	6,84	2,07	2,00	90	4,26

End	Bend forward	Harre	Slalom	Run	Swimming	
	(s)	Test (s)	(s)	(s)	5 min.	25 m (s)
average	12,17	19,70	11,77	7,047	208,8	19,29
st. deviation	5,042	1,565	0,725	0,477	22,37	1,429
median	12,0	19,56	11,74	7,07	207,5	19,45
min.	3	17,20	10,63	6,33	175	17,26
max.	21	22,64	12,95	7,75	240	21,40
var. allowance	18	5,44	2,32	1,42	65	4,14

Significance of the differences between the start and the end of the research.

Test	2,752**	3,020**	2,471*	3,020**	0,044	3,020**
	p < 0,01	p < 0,01	p < 0,05	p < 0,01		p < 0,01

The graph shows changes of special motor tests on land, particularly the slalom with ball test and presents a decrease of coordination in the control group and significant increase in the experimental group during the monitored period (fig.2).

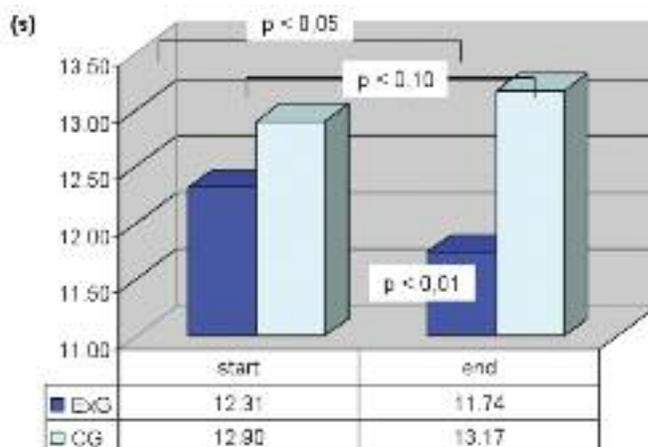


Fig. 2 Statistically significant differences between control and experimental group in the slalom with the ball test

### Conclusion:

- The results in the two group experiment showed that the conditioning program in water for three months significantly affected the development of coordination skills of 17-19 year old soccer players. The level of coordination monitored by special motor tests on land in the control group stayed the same or even got worse. We think that the importance of using changes in body position during exercises as well as the variability of stable support should be considered in creating conditioning programs for various sports.
- Our research proved that the programs in water affect not only the development of conditioning but also special coordination.

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# Application of model trainings in water for young handballers.

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## Introduction

Sport training in handball requires using a wide range of various training means. One of the progressive methods may include training in water environment as a part of condition and regeneration training<sup>2,3,4</sup>. The game load in handball is given by the length and repetitions of physical activities that involve distances of low, moderate and submaximal load<sup>5</sup>. An appropriate fitness program in the water environment stimulates the development of aerobic endurance, endurance in strength, coordination skills and flexibility, whilst the intensity of load may be close to game intensity without the risk of possible injuries<sup>1</sup>.

## Aim

On the basis of monitoring a group of young handballers, we wanted to create and realize model trainings in the water environment for developing chosen physical skills.

## Tasks

1. To measure the level of somatic and physical parameters
2. To create and realize model trainings in water
3. To find out changes in the level of monitored parameters

## Methods

The research group involved 21 handballers of the Police Sport Club Bratislava, Slovakia, who regularly participate on national and international tournaments in the pupils' category. The age of the group

was 12-14 years and consisted of 8 boys and 13 girls. The participants have played handball for 3 to 5 years. Table 1 presents the overview of anthropometric parameters of the research group.

In terms of collecting research data we used the methods of measurement, observation and logic analysis. The results processing was realized by means of basic mathematical and statistical characteristics and for evaluation of significant changes between the measurements at the beginning and at the end we used Wilcoxon T-test. The results were presented in the form of figures and tables.

## Results

Experimental factor - 7 training models in water were applied in the period of 7 weeks during the sport training. The length of training lesson was 45 minutes. The program was realized in 25 m pool with medium and deep water.

The trainings basically included swimming (breaststroke, crawl), legs and arms swimming with swimming board, running and jumping with and without moving, walking, competition activities and stretching exercises. Continuous and interval training methods were used.

Before the beginning of the experiment we monitored the level of swimming performance of the group of boys and girls by 25 m breaststroke and 50m crawl (Tab.2).

**Table 1.** Anthropometric parameters of the research group.

	boys (n=8) age	girls (n=13) HH (cm)	HW (kg)	BMI	age	HH (cm)	HW (kg)	BMI
average	12,38	165,38	55,13	19,78	12,46	164,77	54,85	20,07
max.	13	180	78	24	14	179	75	24,7
min.	12	152	38	15,4	12	153	42	16,2
st. deviation	0,52	9,21	14,84	3,38	0,78	8,55	10,05	2,81

**Table 2.** The level of monitored parameters at the beginning and at the end of the research

	boys (n=8)				girls (n=13)			
	25 m breaststroke [s] (BS)		50 m Freestyle [s] (FS)		25 m breaststroke [s] (BS)		50m freestyle [s] (FS)	
	I. measurement	II. measurement	I. measurement	II. measurement	I. measurement	II. measurement	I. measurement	II. measurement
average	34,94	33,9	63,1	60,85	35,6	33,68	68,14	65,39
max.	39,3	38,9	80,4	76,6	42,8	40,5	92,8	90,3
min.	30,4	28,9	49,3	47	30	28,2	52,4	51,5
st. dev.	2,92	3,68	11,42	11,07	4,04	3,89	10,53	9,84
var. allow.	7,8	10	31,1	29,6	12,8	12,3	40,4	38,8

**Table 3.** Wilcoxon T-test

discipline	boys (n=8)		girls (n=13)	
	T-test	sign.	T-test	sign.
25 m BS	32	p<0,01	87	p<0,01
50 m FS	36	p<0,01	87	p<0,01

The results show a great variety of the swimming performance level especially in the group of boys. Their low level of swimming technique affected the results of the test at the beginning and also the changes of programs for developing aerobic endurance by means of swimming (change of rest intervals and number of series). The girls' group was more balanced in the 25m breaststroke test (s=4,04) than in the 50m crawl test (s=10,53).

On the base of pedagogic observation during the trainings in the water environment, we saw that the exercises with competition character were the most popular (relay-running, swimming), and programs with swimming were harder for boys than for girls. The participants had no problems with interval training using running and walking in water as well as with series of jumps and hops developing strength and endurance. The stretching exercises for developing flexibility of upper and lower body were performed without problems and we understand this as a transfer of the flexibility skills from their specialization realized on land. The training models with

use of swimming and aquafitness positively affected also the level of swimming skills and swimming technique and that was transferred into improvement of performances in the monitored tests with statistical significance ( $p<0,01$ ) in both groups.

### Conclusion

The handballers' reactions on the training models in water environment were very positive. Our recommendation for coaches before applying similar training models is to monitor the level of adaptation in the water environment with swimming performance level if you will use swimming movements.

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# Assessment of motivation and attitude of elderly aquatic fitness participants.

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The aim of this study was to determine the reasons why the elderly practice aquatic exercises. The sample were 101 elderly, 73 female (72.5%) and 28 male (27.5%). They were divided into four age groups: 60-65 years (38.6%), 66-70 years (24.8%), 71-75 years (29.7%) and 76-80 years (6, 9%). To conduct the study, and in order to assess the motivational factors, we applied the questionnaire: "Motivation Questionnaire for Sports Activities" (QMAD, by Serpa & Frias, 1991) with eight motivational factors: i) Status; ii) Physical fitness; iii) Competition; iv) General affiliation; v) Technical competence; vi) Team affiliation; vii) Emotional and viii) Leisure, identified by Fonseca and Maia (2001). The statistical analysis was descriptive and non parametric tests were used. Significance was set at  $p < 0.05$ . Most of the elderly were considered a young elderly, between 60 and 65 (43.1%).

Results showed that older people considered: "Doing exercise", "Being in good physical condition", "To keep fit", "Making new friends" and "Being with friends" as the most important reasons to practice aquatic

exercise. For both genders, masculine and feminine, the choices tend to focus on the same dimensions, that is, giving preference to "Physical Fitness" and "General affiliation," which is in agreement with the average values found on items in the questionnaire.

**Keywords:** Aquatic fitness, elderly, motivation, aging

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# The SykorovaSynchro Method: Aligning mind and body.

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During the course of a person's life, the sensory-motor nervous system continually responds to daily stresses and traumas with specific muscular reflexes. These reflexes, triggered repeatedly, create habitual muscular contractions which cannot be relaxed—at least not voluntarily. This results in stiffness, soreness, and a restricted range of movement. With the SykorovaSynchro educational method, a client is able to align their mind and body while experiencing an alert but relaxed state of being.

The SykorovaSynchro method is based on a somatic viewpoint: Experiences in life result from learned adaptive responses, which can be untaught. This means that sensory motor amnesia (SMA) can be reversed by a program of exercises and passive stretches that are progressive, gradual, and center on specific areas of the body where SMA occurs. The method is also enhancing sensory motor learning based upon the following neurological rule: "The less muscular effort, the more enhanced sensory awareness becomes for learning and physical performance." The primary task is to focus attention on the internal sensation of movement.

A water exercise program based and structured on the principles of the SykorovaSynchro Method promotes body awareness, involves slow passive stretches and easy movements, and activates the brain's movement center in order to generate a flow of valuable information between the brain and the entire muscular system. By enhancing communication between the brain and the rest of the body, a person who listens to the signals of his or her body can ultimately perform better in life's tasks, is better able to cope with physical stress, and develops the ability to recognize social rules and false belief systems. A study was conducted to find out if a water exercise class applying the SykorovaSynchro Method would be beneficial for the improvement of overall health. The study population consisted of six women who were all diagnosed with Fibromyalgia Syndrome. Over the course of 14 weeks, 2x per week, each was required to keep a "Participant's Feeling Journal", and had to rate themselves with a number from 1-5 on their daily feelings in all aspects of overall health based

on the Fibromyalgia Symptoms. The progress was documented each week and compared with a base line established with a starting number expressing a level of self-rated feeling for each screened Fibromyalgia symptom. This method was used to evaluate the progress of "Average Overall Well-Being", "Average Overall Sleep Patterns", "Average Overall Pain", "Average Overall Stiffness", "Average Overall Soreness", "Average Overall Tiredness" and "Average Overall Mood/ Loneliness". The evaluation also included a comparison of week-to-week ratings for "Percentage of Improvement—Overall Well Being" for the first 5 weeks.

Based upon the gathered results the following recommendations can be made: The SykorovaSynchro Method is an appropriate non-medical method for control, maintenance and therapy of FMS and can be a positive part of physical activity for people in early stages of FMS. An improvement of symptoms of FMS was achieved through water exercise in a group setting. A similarly structured exercise program can be incorporated into healthy adult leisure activities for the purpose of improvement in Overall Health as well as enhanced development of physical and spiritual condition. A similarly structured exercise program based on the SykorovaSynchro Method can be incorporated into compulsory and optional school PE programs and physical activities outside school.

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