Comparison of propulsive forces between two head-out water exercises

CATARINA C. SANTOS[1], LUÍS M. RAMA[1,2], RAUL F. BARTOLOMEU[3,4], TIAGO M. BARBOSA[4,5,6], MÁRIO J. COSTA[4,7]

[1]Faculty of Sports Science and Physical Education, University of Coimbra, Portugal
[2]Research Unit for Sport and Physical Activity (CIDAF), Coimbra, Portugal
[3]University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
[4]Research Centre in Sport, Health and Human Development (CIDESD), Vila Real, Portugal
[5]Department of Physical Education and Sports Sciences, Nanyang Technological University, Singapore
[6]Department of Sports Sciences, Polytechnic Institute of Bragança, Portugal
[7]Department of Sports Sciences, Polytechnic Institute of Guarda, Portugal

ABSTRACT

The aim of this study was to analyse and compare the propulsive force between two basic head-out water exercises. Twenty-nine young healthy participants (age: 21.7 ± 1.9 years-old, body mass: 68.5 ± 10.8 kg, height: 168.2 ± 9.6 cm) performed an incremental protocol for each exercise (horizontal adduction and rocking horse) from 105 beats per minute (b·min-1) until 150 b·min-1 with increments of 15 b·min-1 every 30 seconds. Data acquisition required a differential pressure system to obtain propulsive forces in upper limbs', especially the peak force for the dominant member (DPeakF) and non-dominant member (NDPeakF). Force values from both exercises were higher in DPeakF and NDPeakF even when increasing the music cadence and higher forces were found in HAAdd. Differences ($p \leq 0.05$) were found when comparing two exercises at lower music cadences. The main conclusion is that there are significantly differences between two basic head-out water exercises at lower cadences. **Keywords**: Water exercises; Music cadence; Propulsive forces.

Corresponding author. *Estádio Universitário de Coimbra, Pavilhão 3 / 3040-256 Coimbra, Portugal.*
E-mail: katasantos6@sapo.pt
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INTRODUCTION

Previous research in the aquatic fitness has been conducted to understand the acute and chronic physiological adaptations to head-out water exercises or programmes (e.g. Costa et al., 2018). However, there is little evidence on the kinetics of water based exercises. The existing studies just reported propulsive force values in swimming and rehabilitation during vertical head-out water exercises at maximum velocity (Prins et al., 1994; Becker and Havriluk, 2006). As such, there is no insight about the forces produced in different head-out exercises. The aim of the study was to compare the propulsive forces between two basic head-out water exercises at different music cadences.

MATERIAL AND METHODS

Participants

Twenty-nine young healthy subjects, eleven women and eighteen man (age: 21.7 ± 1.9 years-old, body mass: 68.5 ± 10.8 kg, height: 168.2 ± 9.6 cm), volunteered to participate in this study. The following inclusion criteria were considered: (i) at least one year of experience in basic head-out water exercises; (ii) clinically healthy and physically active; (iii) non-pregnant women, and; (iv) not having a muscle-skeletal or neurologic injury in the past six months. The failure to meet any of the criteria excludes the subject from the study.

Measures

Height and body mass were measured using a stadiometer (Harpenden 98.603, Holtain Ltd., Crosswell, UK) and a scale (SECA 770, Hanover, USA), respectively. A differential pressure sensor system (Aquanex, 4.1, Swimming Technology Research, USA), previous validated (Havriluk, 1988) and reported in swimming analysis (e.g. Becker and Havriluk, 2006) was used to collect propulsive forces. Two independent sensors were positioned in both subjects' hands (between the 3rd and 4th fingers) to obtain the following variables: (i) peak force of dominant member (DPeakF, N); (ii) peak force of non-dominant member (NDPeakF, N).

Procedures

The study was held in a 25-m indoor pool with a mean water temperature of 29ºC. After a 3 minutes warm-up, each participant performed at the "water tempo" two basic head-out water exercises: (i) horizontal arms adduction (HAAdd), and; (ii) rocking horse with horizontal arms adduction (RHAdd). The RHAdd is characterized as perform horizontal arms' adduction, fully extended and the hands at 90º angle of attack, with the simultaneous lower limbs' action (Barbosa et al. 2010). In every cycle it was assumed same knee flexion and opposite leg hyperextension between leaps. The level of water surface was set at above jugular notch point.

Each exercise was performed over an incremental protocol, with 4 music cadences or stages, starting at 105 beats per minute (b·min-1) and increasing every 30 seconds by 15 b·min-1, up to 150 b·min-1. The music cadence was controlled by a metronome (Korg, MA-30, Tokyo, Japan) connected to a sound system. All participants gave their written informed consent for the participation and all procedures were in accordance with the Helsinki Declaration in respect to human research.

Analysis

Descriptive statistics (mean and standard deviation) were calculate for pooled sample. A non-parametric Wilcoxon Signed-Rank Test was used to compare differences between exercises in the selected variables. The level of statistical significance was set at $p \leq 0.05$.

RESULTS

Table 1 presents the comparison of dominant and non-dominant upper-limb between HAAdd and RHAdd according to the music cadence.

Table 1. Comparison of dominant and non-dominant upper-limb between two exercises at the incremental protocol

		Horizontal adduction (HA_{Add})	Rocking horse (RH_{Add})	
Cadence (b·min-1)	Variables	Mean ± SD	Mean ± SD	*p* value
105p	DPeakF [N]	30.96 ± 11.25	26.40 ± 7.73	0.006
	NDPeakF [N]	29.42 ± 9.79	25.81 ± 7.64	0.016
120	DPeakF [N]	36.61 ± 12.30	33.18 ± 10.02	0.025
	NDPeakF [N]	35.47 ± 10.57	32.09 ± 8.23	0.066
135	DPeakF [N]	42.30 ± 13.20	41.07 ± 12.00	0.381
	NDPeakF [N]	41.53 ± 11.54	41.03 ± 12.37	0.779
150	DPeakF [N]	48.05 ± 13.60	47.89 ± 14.44	0.922
	NDPeakF [N]	48.92 ± 12.89	46.46 ± 15.56	0.030

Note: b·min-1, beats per minute; SD, standard deviation; DPeakF, dominant peak force; NDPeakF, non-dominant peak force; N, Newton.

DISCUSSION

As expected, the DPeakF was higher than the NDPeak force in both exercises at majority of the cadences. When comparing exercises, there were higher forces for the HAAdd which were more pronounced at lower cadences. This means that at slower cadences the RHAdd promote lower force values compared to HAAdd probably due to imbalances, caused by multiple hops and the range of motion of the knee. For instance, we can have similar exertion pattern when adopted a static position or an imbalance position at higher music cadences, because the short time contact with the ground can lead to similar force values and even less hypothetic asymmetries.

CONCLUSIONS

To conclude, there are significantly differences between two basic head-out water exercises at lower cadences. So, head-out water fitness professionals should pay major attention and prescribe the exercises properly, when attempting to develop strength in water.

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