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HEAD-OUT AQUATIC EXERCISE "SAILOR'S JIGS" KINEMATICS AT INCREASING MUSICAL CADENCE

1. Introduction

Head-out aquatic classes are most of the time full with dozens of subjects, having instructors a greater challenge to maintain all of them synchronized. Instructors use on regular basis the music cadence 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).

The aim of this study was to analyze the relationships between "Sailor's jigs" kinematic and increasing music cadence. It was hypothesized that increasing musical cadence will decrease the cycle period and, therefore, the segmental range of motion.

2. Methods

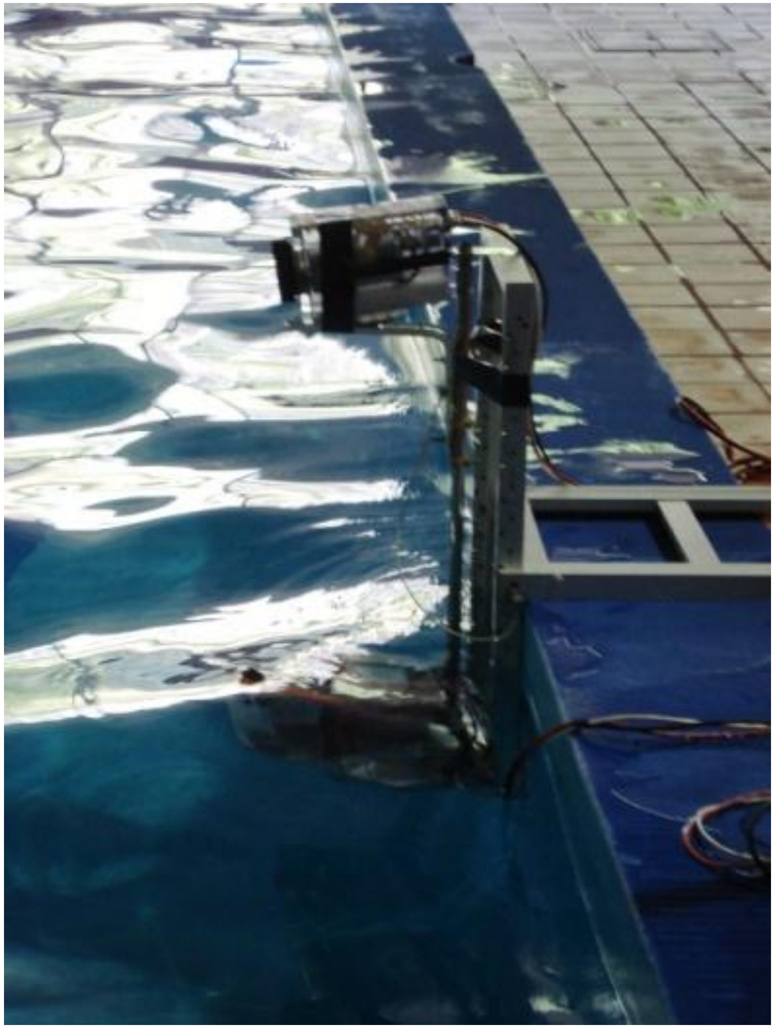
Subjects. Six young women, non-pregnant, clinically healthy and physically active, holding a graduation degree in Sports Sciences and with at least one year of experience conducting head-out aquatic classes, volunteered to participate in this study (23.50 3.51 years-old; 57.17 4.07 kg of body mass; 1.66 0.06 m of height; 20.60 0.55 kg/m^2 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.

Procedures. Each subject performed a basic head-out aquatic exercise entitled "Sailor's jigs". The exercise was performed using the ''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).

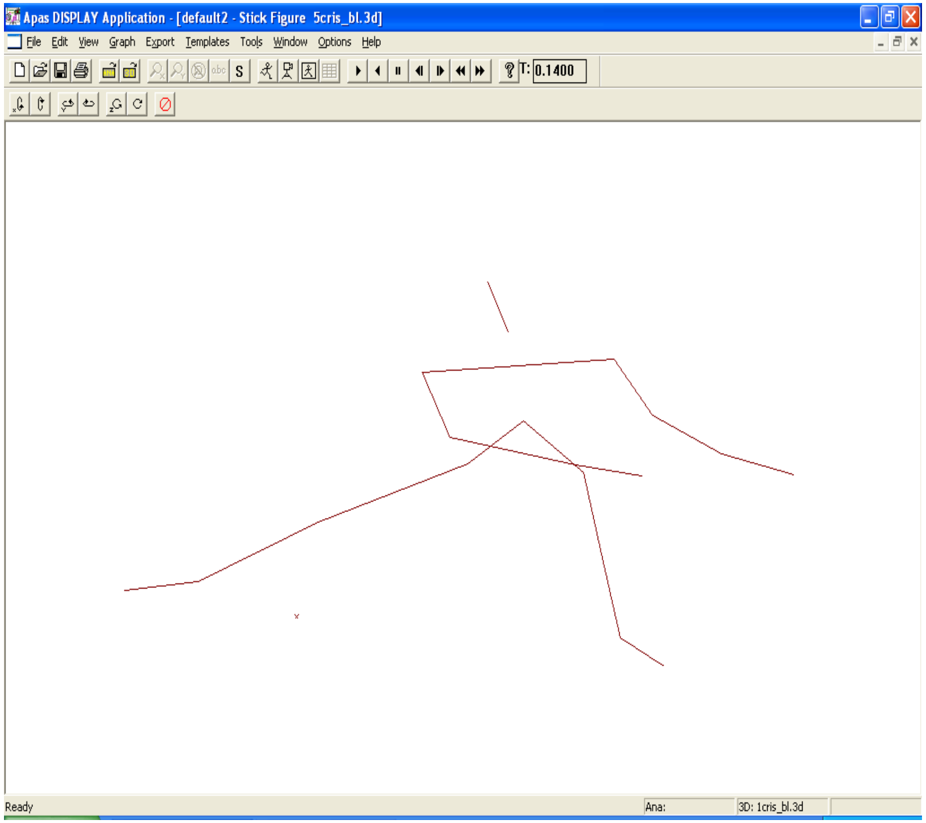
The protocol consisted of five sets of 16 full repetitions of the "Sailor's jigs" exercise, at the "water tempo", immersed to the xiphoid process (i.e., breast). The bouts intensities were 80 [%], 90 [%], 100 [%], 110 [%] and 120 [%] of the cadence reported by Barbosa et al. (2010a) to achieve a 4 [$mmol.l^{-1}$] of blood lactate, representing 120 [$b.min^{-1}$], 135 [$b.min^{-1}$], 150 [$b.min^{-1}$], 165 [$b.min^{-1}$] and 180 [$b.min^{-1}$], respectively. The musical cadence was electronically controlled by a metronome (Korg, MA-30, Tokyo, Japan) connected to a sound system.

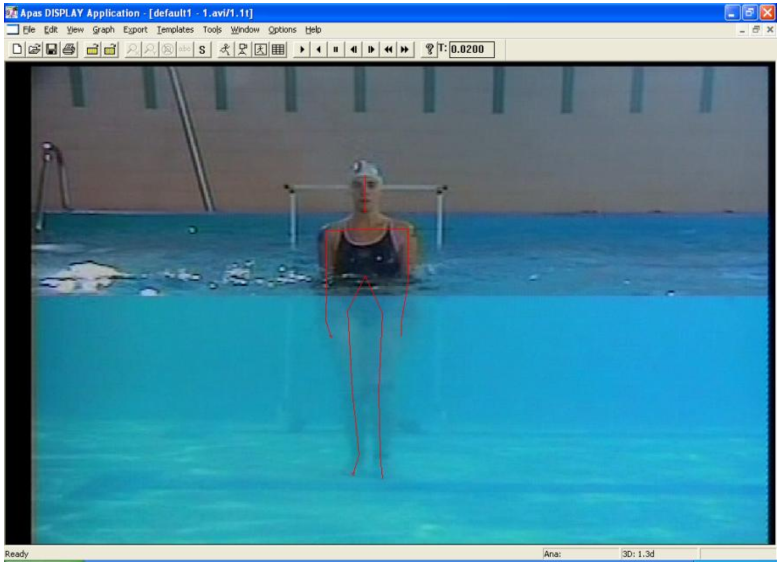
Whenever necessary, the evaluators gave verbal and/or visual cues for subjects to follow the appropriate exercise cadence and accomplish the number of repetitions asked. All subjects completed the protocol's five bouts. The water temperature was 30ºC and the relative humidity was 75 [%].

Data Collection. The protocol was videotaped independently in 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.



Data Collection (cont). 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. It was assessed the: (i) cycle period (P, s); (ii) range of motion ($\Delta\phi$, º) of the thigh-trunk, lower leg-thigh, upper arm-arm from left and right sides and; angular velocity (ω, º/s) thigh-trunk, lower leg-thigh, upper arm-arm from both sides



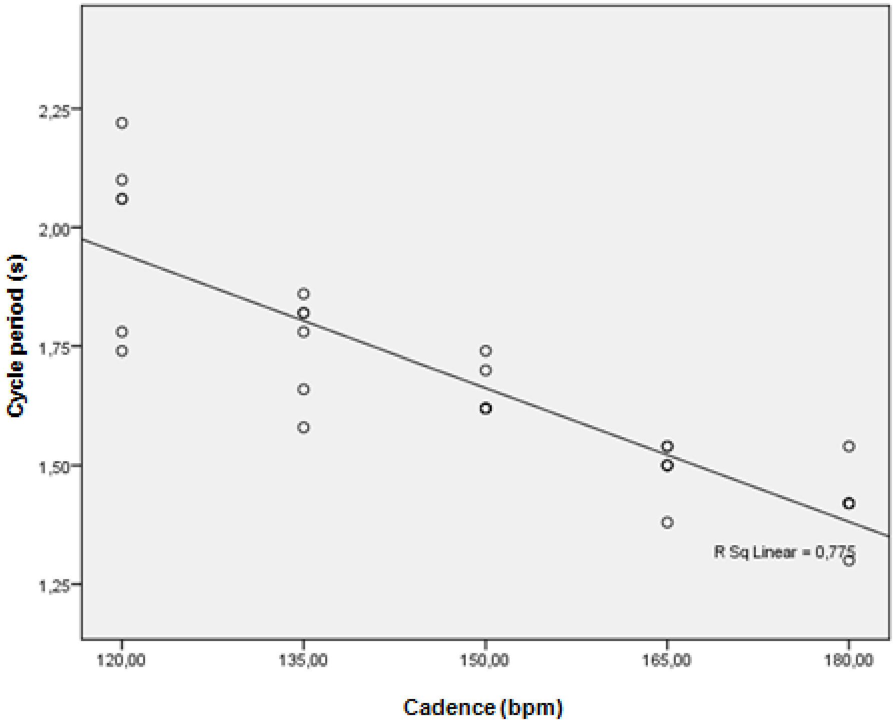


Statistical Procedures. The normality of the distributions was assessed with the Shapiro-Wilk test. For descriptive analysis, mean plus one standard deviation were computed as central tendency and dispersion measures, respectively. For each relationship, the mathematical model with the best good-of-fit adjustment and the lowest standard error of the 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 $P \leq 0.05$.

3. Results

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 ω or; (ii) maintaining the joint's $\Delta\phi$ and increasing the ω or; (iii) combining both. So, it is useful to assess both angular displacements and velocities for upper and lower limbs, in order to clear it out.



4. Discussion

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 ω with increasing musical cadence but with no statistical meaning for most selected variables, except for the right side thigh-trunk ($R^2 = 0.133$; $P = 0.047$).

The decrease of the cycle period is achieved through a combined way, decreasing the $\Delta\phi$ and increasing the ω.

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 ω) reveals that subjects decrease the cycle period mainly decreasing the joints range of motions.

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5. Conclusions

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 perform the exercises in the full range of motions, following the selected exercise cadence.

6. References

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