A KINEMATICAL, IMAGIOLOGICAL, AND ACOUSTICAL BIOFEEDBACK SYSTEM FOR THE TECHNICAL TRAINING IN BREASTSTROKE SWIMMING.

Lima AB1,2, Sembiano P1, Fernandes D1, Gonçalves P1, Moroço P1, Sousa P1, Fernandes R1, Barbosa T1, Correia MV1, Tani G1, Vilas-Boas JP1

1University of Porto, Faculty of Sport, Porto, Portugal
2University of Ceà and University of Fortaleza, Fortaleza, Brazil
3University of Porto, Faculty of Engineering, Porto, Portugal
4Department of Sports Sciences, Polytechnic Institute of Bragança, Portugal
5University of São Paulo, São Paulo, Brazil.

INTRODUCTION

A system for real time velocimetric feedback, and for immediate disposal of kinematical data, and model, synchronized with dual-media video images, will be presented.

DESCRIPTION

The system is composed by three different units: (i) a dual-media image setup (Vilas-Boas et al., 1997), upgraded for images in follow up; (ii) a cable speedometer (Lima et al., 2006), and (iii) a FM transmitter/receiver system, adapted for swimming use, and able to deliver real time velocimetric information to the swimmer and coach. The dual-media follow up images setup uses a special chariot to move, along the lateral wall of the pool, a set of two video cameras: one underwater camera (Submergible AC230V), and one over-water (IVC GRSX1, SVHS). The images of both cameras are mixed (Panasonic Digital AV Mixer WJ-AVE5), edited (Sony Color Trinitron TV monitor) and recorded (Panasonic AG-7330). Differences in refraction are corrected using the zoom optics of the over-water camera, and a calibration device. The dual-media images are mixed with the display of a PC with kinematical information provided by the speedometer. This is a device for measuring the rotational velocity of a cylinder over which a fine nylon cable is passing through. This cable is fixed to the swimmer at hip’s level. The movement of the cylinder is monitored by a rotating incremental coder connected to a microcontroller (PIC18LF1320, Microchip). A electrical brake motor allow the reduction of the inertia of the all system, keeping the cable straight, and also allows the cable recoil action. The speedometer was also equipped with a audio output, that allow a sound of variable frequency to be sent to the swimmer and coach through AM/FM receivers (Roadstar TRA-2221D) placed below the swimmers cap.

RESULTS

Results are in real time curves, synchronized with images, and with corresponding auditory sounds. The software also allows the immediate modelling of a typical stroke cycle, both bimodal or trimodal, displaying mean velocities in noticeable points, mean phase durations and accelerations.

REFERENCES


Bockenem: Sport Fahnemann Verlag, 95-103.

DYNAMOMETRIC SYSTEM FOR THE EVALUATION OF SWIMMING TURNS.

Pereira S1,2, Roesler H1, Esteves C1, Gonçalves P1, Sousa P1, Conceição F1, Machado L1, Lima A1,3, Vilas S1, Fernandes R1, Vilas-Boas JP1

1University of Porto, Faculty of Sport, Porto, Portugal
2State University of Santa Catarina, Florianópolis, Brazil
3University of Ceà and University of Fortaleza, Fortaleza, Brazil.

INTRODUCTION

A system for the dynamometrical evaluation of swimming turns will be presented.

DESCRIPTION

The system is composed by one underwater force plate, specifically developed for this purpose, and based on the general characteristics described by Roesler et al. (2003). The force plate is fixed to the ending wall of the pool through a specific structure conceived for this purpose.

The force plate is connected to a PC using a Biopac (Biopac Systems HLC100) A/D converter, operating under control of the Acknowledge software. Landmarks in the bottom of the pool needed to be changed in order to keep the official distance from the “T” mark to the ending wall.

RESULTS

The system displayed allow the assessment of variables such as:

(i) contact time;
(ii) impulse time;
(iii) horizontal component of the platform reaction force;
(iv) horizontal impulse.

Results also allow perceiving the effect of different turning techniques on the measured parameters, as well as the effects of different variants of one same technique.

CONCLUSION

Results provided for such a dynamometrical setup allow swimmers to test their best solutions for turning actions, as well as to train their technique, disposing of immediate feedback about critical variables for the performance in this particular action.

DEVELOPMENT OF A MULTI-MEDIA SYSTEM FOR KINESTHETIC EVALUATION OF SWIMMING BY EXPERTS IN ANY POOL.

Soons B, Colman V, Persyn U

Faculty of Kinesiology and Rehabilitation Sciences, K.U.Leuven (Leuven), Belgium.
RESULTS
The results pointed out: i) a somatic anxiety decreased during the intervention period; ii) positive thoughts decreased from intervention to follow-up; iii) imagery dimension, image control, emotion control and seeing was significantly higher in intervention when compared with follow-up; and finally; iii) broad internal attention was significantly higher in intervention when compared with follow-up.

DISCUSSION
Preliminary data analyses suggest that mental variables have an evolutionary profile similar to the same demonstrated for swimming performance. Mental and performance data appear to converge over time as mental skills and procedures are mastered. The integrated psychological program employed also seems to influence swimmers' general psychological profile and indirectly their motor development. In the follow-up there is a regression as to psychological and performance profile. Structural methodologies and principles underlying physical and psychological training appear to be similar.

REFERENCES

VELOCIMETRIC CHARACTERIZATION OF A 30 SEC MAXIMAL TEST IN SWIMMING: CONSEQUENCES FOR BENOERGETICAL EVALUATION

Soares S1; Machado L1; Lima A2; Santos F1; Fernandes R1; Correia M1; Maia J1; Vilas-Boas JP1

1University of Porto, Faculty of Sport, Porto, Portugal;
2University of Coimbra and University of Fortaleza, Fortaleza, Brazil;
3University of Porto, Faculty of Engineering, Porto, Portugal;

INTRODUCTION
The existence of a valid direct method to evaluate anaerobic proficiency of swimmers is still a matter of controversy. The use of an alactic-lactic threshold has never been feasible, namely due to the difficulty of exactly quantify the alactic energetic contribution to an effort (1). Moreover, the possible existence of that threshold remains strictly theoretical. In the present study, the use of a velocity decay analysis during a maximal swimming test is related to a possible transition from a mainly alactic to a lactic metabolic pathways. Different maturational statuses of swimmers are considered.

METHODS
A total number of 72 swimmers performed a 30 sec maximal front crawl test connected to a mechanical speedometer developed by our investigation group (2). This velocimetric system produced individual curves of the instantaneous velocity corresponding to each swimmer total effort time. Data treatment was performed using a routine, written by our research group,
in the Matlab program. We started by removing the start, glide and final phases of the velocity curve, and then a continuous wavelet analysis of this curve was performed. From the wavelet results it was possible to discriminate one, or more, points separating zones of different spectral characteristics, that we loosely call fatigue thresholds.

RESULTS AND DISCUSSION

Results revealed a tendency to an inverse relationship between the number of different fatigue thresholds and maturational status. This should be related to a less mechanically stable swimming technique of younger swimmers. The velocity curves for all studied groups are mainly characterized by two fatigue thresholds. The first fatigue threshold was found to be around 8 to 12 sec (Table 1). It seems to be legitimate to speculate about the possibility of using the velocity curves to determine the individual alactic-lactic threshold in order to better plan and control anerobic swimming training.

Table 1. Mean effort time (sec) and respective standard deviation corresponding to velocity curves with one or two fatigue thresholds.

<table>
<thead>
<tr>
<th></th>
<th>One threshold</th>
<th>Two thresholds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st threshold</td>
<td>2nd threshold</td>
</tr>
<tr>
<td>Post-pubertal</td>
<td>12.5±1.58</td>
<td>8.94±1.55</td>
</tr>
<tr>
<td>Pubertal</td>
<td>13.6±1.34</td>
<td>9.42±1.58</td>
</tr>
<tr>
<td>Pre-pubertal</td>
<td>8.44±2.80</td>
<td>17.06±2.95</td>
</tr>
</tbody>
</table>

REFERENCES


ANALYSIS OF USA SWIMMING'S ALL-TIME TOP 100 TIMES.

Sokolovas G

USA Swimming, Colorado Springs, U.S.A.

INTRODUCTION

There is a paucity of studies on effects of early high-level performances on athletes’ progression later in their career (1, 2). The purpose of this study was to investigate the performances of elite level swimmers based on the All-Time Top 100 times.

METHODS

We analyzed USA Swimming’s All-Time Top 100 age group times by girls and boys. The following swimming events were analyzed: 100, 200, and 500 freestyle; 100 and 200 backstroke; 100 and 200 breaststroke; 100 and 200 butterfly; and the 200 individual medley.

RESULTS

Data presented for age groups includes elite swimmers from Top 100 at age 17-18 in all events (Figure 1). The data shows that the number of participants in all events increases exponentially from age 10-under until the age of 15-16 years. As it was expected, the older the elite swimmer, the more likely he/she will be ranked in the Top 100. About half of the elite swimmers in the Top 100 at age 17-18 were new swimmers who were never ranked in the Top 100 at any age.

DISCUSSION

The analysis shows that most of elite level swimmers were unknown at young ages. Most of the future elite swimmers swim slower than age group champions, especially at ages until 15-16 years. Many participant ranked in the Top 100 as age groupers are not present in the Top 100 in the 17-18 age group. We speculate that the two reasons for losing these young Top 100 ranked champions may be related to their early biological maturation and/or an inappropriate training volume at a young age.

REFERENCES


EVIDENCE OF INSUFFICIENT PULMONARY VENTILATION DURING CRAWL SWIMMING WITH MAXIMAL AND SUPRAMAXIMAL INTENSITIES.

Strumbelj B, Usaj A, Kapus J, Bednarik J

University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia.

INTRODUCTION

Respiration during front crawl swimming is limited with swimming technique. In the previous studies found no indication of hyperventilation (1), however only saturation of blood with
REFERENCES

ACUTE EFFECTS OF THE USE OF A BIOFEEDBACK SYSTEM FOR THE TECHNICAL TRAINING IN BREASTSTROKE SWIMMING.

Lima, A1,2, Capitão P1, Morouço P1, Gonçalves P1, Fernandes R1, Barbosa P1, Correia M1, Tani G1, Vilas-Boas JP1
1University of Porto, Faculty of Sport, Porto, Portugal
2University of Coimbra and University of Fórtaleza, Fortaleza, Brazil
3Department of Sports Sciences, Politechnic Institute of Bragança, Portugal
4University of Porto, Faculty of Engineering, Porto, Portugal
5University of São Paulo, São Paulo, Brazil.

INTRODUCTION
The purpose of this research was to develop, validate, and evaluate a biofeedback system for the technical training in breaststroke swimming. The system relied on the assessment of speed fluctuation curves of an anatomical landmark of the swimmer (hip).

METHODS
The research developed through the informations displayed by a cable speedometer, specifically produced for the study, which signal was synchronized with dual media video images of the swimmer’s performance. The velocimeter signal was graphically registered, and acoustically provided to the swimmer and coach during the performance. For the appreciation of the utility of the biofeedback solutions proposed for the technical training of breaststrokers, the acute effect of their use was analysed. For that purpose, the acute biomechanical response of five homogeneous (speed fluctuations and sex) groups to five different technical training programs with one hour of duration were studied. All the groups intended to minimize the speed fluctuations within a stroke cycle (dv = variation coefficient (VC) of the instantaneous velocity distribution) at the mean velocity correspondent to the race pace of the 200m breaststroke event. The sample was composed by 50 swimmers distributed by five groups of 10. Group 1 used only informations provided by the swimmer’s coaches, Group 2 used also the graphical data provided by the speedometer, Group 3 included also dual media video images, and groups 4 and 5 accumulated concomitant acoustic informations (Group 4 every cycle, and Group 5 once in each two cycles).

RESULTS & DISCUSSION
VC ranged from 0.40 to 0.43, without statistical significant differences between groups. The mean values of stroke length (SL) were between 1.41m and 1.65m, with less homogeneity between groups. The cycle duration (T) ranged between 1.5sec and 1.7sec. The mean velocity per cycle (V) was between 0.9m.s⁻¹ and 1.0m.s⁻¹, and the Stroke Index (SI=V-SL) varied between 1.4 and 1.4m².s⁻¹. The higher positive acceleration values were observed, in all groups, during the propulsive leg action, and ranged between 4.8m.s⁻² and 5.7m.s⁻². Among the main conclusions of this research, it is possible to state that: (i) the use of the biofeedback devices (graphical and acoustic displays of the speedometer, and dual media video images) influenced the motor learning processes associated to the acute effect of the swimming technical training provided - this effect is as larger, as higher and frequent the quantity of information provided; (ii) the swimming technical training of one hour of duration, complemented or not by additional technological means, has as acute effect a depression of the subjects' technical ability; (iii) the technical changes with training, at least during a one hour process, are not temporal, but spatial, or derived ones (velocity, and acceleration), and each group distinguished from the others, in each evaluation moment, from very detailed and changing technical variables.

EVOLUTION OF BUTTERFLY TECHNIQUE WHEN RESISTED SWIMMING WITH PARACHUTE USING DIFFERENT RESISTANCES.

Llop F1, Tella V1, Colado J1, Díaz G1, Navarro F1
1Department of Physical Education of the University of Castilla La Mancha, Spain
2University of Valencia, Spain
3University Alcántara, Spain.

INTRODUCTION
The use of resistance training with parachute, modifying posterior diameter, produces variations in the stroke frequency (SF), the stroke length (SL), speed (S) and stroke index (SI) during swimming. It is necessary to observe the progressive modifications produced in these parameters as the resistance swimmers must drag is increased. With this data trainers can decide the type of load and period of preparation in which it should be used, in order not to negatively affect swimmers' performance. It will also permit him to know which parameters have greater variability and must be controlled during training.

METHODS
The study was carried out with 18 swimmers of national level between 19 and 22 years of age. They carried out 6 tests consisting in swimming butterfly style 25 meters at maximum intensity using normal swimming (NS) and resisted swimming with parachute (RSPW) with a front diameter of 30cm and a posterior diameter of 30cm, 22.5cm, 15cm, 7.5cm and 0cm. The lap times and number of cycles in the central 10 meters, of the 25 meter distance were registered. SF, SL, S, and SI variables were analyzed in these tests. An intra-subject design was applied and the study of the data was carried out by means of a variance analysis for repeated measures.

RESULTS
The results obtained showed how the SF does not significantly differ with different spans, but there are significant differences between NS and 0cm (p=0.015), 15cm (p=0.001) and 30cm.
COMPUTATIONAL ANALYSIS OF THE TURBULENT FLOW AROUND A CYLINDER.

Moreira AM¹, Rouboa AF¹, Silva AF², Sousa L², Marinho D², Alves FB¹, Reis VM², Vilas-Boas JP², Carneiro AL¹, Machado L¹

¹Superior School of Sport, Porto, Portugal
²University of Trás-os-Montes and Alto Douro, Vila Real, Portugal
³Centre of Studies, Technology, Environment and Life, CETAV, Portugal
⁴Faculty of Human Movement, Technical University of Lisbon, Lisbon, Portugal
⁵Faculty of Sport, University of Porto, Porto, Portugal

INTRODUCTION

Nowadays, two techniques to study the turbulent flow around a cylinder (important for some sports) are being used: computational fluid dynamics (CFD) and measurement of the pressure. The aim of this study was twofold: i) to evaluate the CFD code capacity to solve simple problems of the turbulent flow around a cylinder, by the comparison of values from different turbulence models with experimental values for similar Reynolds number (Re); ii) to evaluate, for the most appropriate computational model, the thickness of the adjusted mesh in order to apply it to similar RE values as it is in swimming.

METHODS

For this purpose, various turbulent models were applied (k-ε; k-ω; Spalart-Allmaras; Reynolds Stress) with different mesh spacing (from 0.1 to 0.4). The first model was considered for treatment of the geometry and conformation of the model. This first model was allowed only the mesh generation but also to define the necessary boundary conditions to the application in the commercial code Fluent. The velocities changed from 0.1 to 10.0 m/s in order to obtain the same Re numbers usually observed (Re from 10⁵ to 10⁷) in human swimming. The model was considered as a fixed element with null velocity.

RESULTS

The results obtained confirm that the analysed resistance coefficients (for Re of 10⁵, 10⁶, and 10⁷) decreased with the increase in Re number. It was also found that an increase in the fluid velocity and an increase of Re above 10⁵ a turbulent flow appeared in the wake of the cylinder, just like the expected by the fluid mechanics theories, assuming a zone of low pressure and high velocity of fluid displacement.

DISCUSSION

We can conclude that the results show the FLUENT code the best turbulent model to apply in the numerical study, using the computational fluid dynamic approach, of human locomotion in Re from 10⁵ to 10⁷. However, the use of a mesh spacing of 0.10 is recommended.

VALIDATION OF A CABLE SPEEDOMETER FOR BUTTERFLY EVALUATION.

Moroçu P¹, Lima A¹, Simbono P¹, Fernandes D¹, Gonçalves P¹, Sousa T¹, Barbosa T¹, Correia MV¹, Vilas-Boas JP²

¹Polytechnic Institute of Leiria, School of Management and Technology, Portugal
²Faculty of Sport, University of Porto, Porto, Portugal

INTRODUCTION

Most of the approaches available for technical evaluation of swimmers are very expensive and time consuming. Thus, one of the most important goals to achieve in swimming research should be to get fast and interactive results from the evaluation process. The purpose of this research was to compare the real-time velocimetric results obtained from a cable velometer with those extracted from computerised videogrammetry.

METHODS

Seven swimmers (including 3 females and 4 males) from the Portuguese national team were studied. Each swimmer performed, with a start in water, 2 repetitions of 25 m butterfly: one at race pace of a 200-m event (V200m) and the other at the maximal pace of a 50-m event (V50m). Two stroke cycles for each repetition were analyzed, resulting in a total number of 28 observations. The swimmers were attached by the hip to a cable, connected to a speedometer (Lima et al, 2006) that displays a real time v(t) graphic of the intra-cyclic velocity of the hip of the swimmer. To validate the results provided by the speedometer, it was conducted a computer assisted videogrammetric analysis. The trials were simultaneously video-taped, in the sagittal plane, with a set of two cameras providing dual-motion images. Ariel Performance Analysis System (APAS) from Ariel Dynamic Inc. was used to digitize the stroke cycles analyzed with the speedometer. 24 anatomical landmarks were digitized in each frame, allowing the division of the trunk in 3 articular parts. Coefficients of correlation between the intra-cyclic variation of the hip velocity obtained with speedometer (Vhip), with videogrammetry (Vvg) and the intra-cyclic variation of the centre of mass (Vcm) were computed.

RESULTS

The individual Pearson correlation coefficients were highly significant (p<0.01) and their mean values were: (i) between Vhip and Vvg, (ii) between Vhip and Vcm.
and $v_{902}$: $r=0.96 \pm 0.03$; (ii) between $v_{494}$ and $v_{CM}$: $r=0.92 \pm 0.05$ and (iii) between $v_{902}$ and $v_{CM}$: $r=0.88 \pm 0.05$.

DISCUSSION
It was concluded that the speedometer is a real-time reliable apparatus for the analysis of the intra-cyclic variation of the velocity of the hip in butterfly stroke. Moreover, the speedometer avoids: (i) the high costs and time spend with videogrammetry, (ii) the errors of digitalization, and (iii) the need of special expertise to conduct the analysis. It allows, inclusively, the concomitant display of kinematical data with video images of the swimmer; all these advantages without compromising the swimmers performance.

REFERENCES

EMG ANALYSIS OF THE MUSCLES PECTORALIS MAJOR AND DELTOID POSTERIOR.

Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

INTRODUCTION
Only few studies exist about the neuromuscular activity during exercise in an aquatic environment. A good understanding about efficient movement patterns is necessary for the planning of training. We therefore studied muscle activity (EMG) during arm movements in water at different velocities.

METHODS
Four woman aged between 20 and 25 years participated in this study. Electromyographic activities of the posterior Deltoid and the Pectoralis major muscles were analysed during horizontal flexion and extension movements of the shoulder. Participants performed 8 repetitions in four cadences: at 40, 60 and 80 bpm, paced by a metronom. These repetitions were also performed at maximum velocity. The electromyographic sign was filtered and the RMS values of the third, fourth and fifth repetition were analysed. An ANOVA statistics analysis for EMG was performed to verify the velocity (cadence) effect ($p<0.05$).

RESULTS
The EMG values were normalized to maximum velocity and are represented by percentage of maximum velocity. The value for the posterior Deltoid and the Pectoralis major were, respectively: cadence 40 bpm (13.6±13.75 and 31.02±8.88), 60 bpm (20.2±17.18 and 56.64±22.86), 80 bpm (37.91±27.05 and 70.12±23.93). The post hoc test LSD demonstrated increased RMS values which went along with the increase of the cadences. The exercise realized in the cadence of 80 bpm showed a statistically relevant difference from the exercise realized in cadence 40 bpm in the electromyographic sign for both analyzed muscles.

DISCUSSION
A significant increase of the electromyographic activity is provoked probably because of the need of a larger number of motor units, since the liquid environment offers more resistance when the movement is done at higher speed (1). This shows that movement speed could be a useful tool for the control of the exercise or training in the liquid environment.

REFERENCES

ELECTROMYOGRAPHIC DIFFERENCES OF ABDOMINAL EXERCISE IN WATER AND ON LAND.

Universidade Federal do Rio Grande do Sul, Porto Alegre, Brasil.

INTRODUCTION
There are a lot of researches about the electrical activity of the abdominal muscles on land, but little is known about the EMG behavior when the exercise is carried through in water. This research verifies the electric activity of the abdominal muscles and hip flexor muscles during the "sit up" exercise in land and water.

METHODS
Twenty woman aged between 21 and 29 years participated. The electric activity of the Obliques externs abdominis (OE), Rectus femoris (RF) and of the Rectus abdominis (RA) were measured with surface electrodes. The exercise of trunk flexion up to a seated position, performed on land was used as standard exercise and the root mean square (RMS) of the ascending phase of this exercise were being used for normalization the signal that was collected during another variations of speed and environment. Trunk flexions in water were performed in a horizontal position with the support of a floating device for the upper members. The exercise was performed in a standard rhythm and also in maximum speed. For each muscle ANOVA was used for the factors phase, speed and environment ($p<0.05$) was performed.

RESULTS
Statistically differences were found in the mean value of the percentual of EMG activation when the two phases, two environments and two speeds were analysed separately for all muscles; in the interaction of the factors environment/phase the muscles RF, upper and lower RA and OE in the interaction of the factors environment/speed to the muscles upper and lower RA and OE and in the interaction of the factors phase/speed for all muscles analysed. When the exercise was performed in maximum speed and in the ascending fase of the exercise in the water the observed EMG activity was stronger than the muscle activity for the exercise performed in standard speed. This was observed in water and on land. The EMG activity of the RF when performing the exercise in maximum speed in water was lesser than on land.
Yth INTERNATIONAL SYMPOSIUM

Biomechanics and Medicine in Swimming

PORTO > PORTUGAL > 2006

Book of Abstracts

J.P. Vilas-Boas, F. Alves, A. Marques (eds.)
IN MEMORIAM
INVITED LECTURES
POOLSIDE DEMONSTRATIONS
ORAL PRESENTATIONS
POSTER PRESENTATIONS