27th Annual Congress of the

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BOOK OF ABSTRACTS

Edited by:

Dela, F., Piacentini, M.F., Helge, J.W., Calvo Lluch, Á.,
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FACING THE ANAEROBIC THRESHOLD – A FACIAL ELECTROMYOGRAPHY APPROACH FOR PHYSIOLOGICAL THRESHOLDS IDENTIFICATION DURING AEROBIC EXERCISE TESTING

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INTRODUCTION: Non-invasive, real-time monitoring of athletes' fatigue during exercise is crucial for performance enhancement and to avoid over-training and exercise-related injuries. Facial expressions quantification through facial surface electromyography (sEMG) have a great potential in fatigue evaluation and in quantifying fatigue related outcomes. Yet, despite increased interest and the great potential [1,2], this topic has not been widely studied, apparently due to a technical gap in sEMG technology that does not allow convenient and accurate measurement especially during dynamic exercise. Recently, a novel sensor of multiarray electrodes was introduced. The sensor was already used for long term recording in freely behaving humans [3] and for emotional affect sensing [4] and demonstrated the ability to measure "masked" smiles, and to detect diverse facial expressions for emotional affect recordings. In the current study we measured and analyzed facial muscle activity in response to the anaerobic threshold during a graded exercise test.
METHODS: 5 young, healthy, and recreationally active participants (2 females) performed an incremental cycling exercise test consisting of 3 min stages, below the lactic-acid based threshold, and increasing resistance every 1 min until exhaustion. Facial sEMG which was applied on the participant's left side of the face, covering the forehead, zygomatic, buccal, nasal, and labial regions by 16 embedded electrodes was recorded continuously throughout the exercise test. Blood lactate and heart rate were documented at each exercise stage. The envelope root mean square (eRMS) of the facial EMG signal at natural-expression, recorded from each electrode, was calculated, and then averaged for each stage, including during a 3 min recovery period. sEMG data was then transformed into heatmaps and correlated with exercise intensities. Paired T-test and Pearson's correlation coefficients were used to analyze differences between eRMS and facial expressions.
RESULTS: Average eRMS (obtained from 5 subjects X 16 electrodes each) showed a stepwise increase with exercise intensity, reaching a maximal value of 2.12±1.03 [μV], versus 1.22±0.437 [μV] for light intensity ($p<0.05$). After reaching maximal value, a gradual and significant decrease in eRMS values was measured during the recovery period: 1.09±0.601 [μV] versus the maximal value, $p<0.05$. eRMS values were highly correlated with blood lactate and exercise intensity ($r=0.975$, $p<0.05$).
CONCLUSION: Our novel multiarray sEMG electrodes is highly stabilized during dynamic exercise. In addition, facial expressions are correlated with exercise intensity and can predict the anaerobic threshold. This technology may be used under various exercise protocols to further understand the role of facial expressions during exercise.

REFERENCES:
1. de Morree & Marcora (2010) 2. Chen & Chung (2004) 3. Inzelberg, Rand et al. (2018) . 4. Inzelberg et al. (2018)

COMPARISON OF THE CARDIO-RESPIRATORY RESPONSE DURING DEEP WATER RUNNING TRAINING VS INDOOR CYCLING TRAINING IN HEALTHY ATHLETIC SUBJECTS

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INTRODUCTION: Running sports often lead to lower limb mechanical injuries, such as ligament rupture or cartilage wear. During the recovery phases, it is often advised to practice unloaded sports such as indoor cycling (IC), to maintain a good physical condition with limited mechanical stresses1. However, despite these recommendations, the injured athletes often lose cardio-pulmonary capacity and suffer from physical deconditioning when returning to the field. Therefore, we studied an alternative training that can be proposed: deep water running (DWR). DWR has previously been showed to reduce low-limb overload, improve muscle strength2 and balance3, while water resistance forces the subject to exert greater force than moving in air4. We therefore compared the cardio-pulmonary parameters during two types of continuous trainings: DWR and IC.
METHODS: Eight active healthy subjects were enrolled in the study; 23±3 yo, 50% women, maximal oxygen consumption (VO2max) measured during a cyclo-ergometric cardio-pulmonary exercise test (CPET) of 42±5 ml/min/kg. All subjects performed randomly a DWR and an IC continuous training session, with a minimum 24h between both sessions. Training sessions consisted of a 5-minutes warm-up at 80% of HR at first ventilatory threshold (VT1), followed by 10 minutes training at 100% HR at VT1, 2 minutes rest and again 10 minutes at 100% HR at VT1. For the DWR session, subjects wore a flotation belt (Nabaji) and two "pool noodles" below their arms, to maintain their head and shoulders above water. Heart rate (HR), gas exchange and ventilation (VE) were measured continuously during CPET and DWR/IC training sessions with lactate levels measured 30s after exercise. Oxygen consumption (VO2), VE and lactate during DWR and IC training were compared, with VO2 and VE averaged during the last minute of the training session.
RESULTS: At same HR, VO2 was significantly ($p=0.0002$) higher during DWR (40±7 ml/min/kg; 97±15% of VO2max) as compared to IC training (29±5 ml/min/kg; 69±13% of VO2max). At same HR, VE was significantly ($p=0.0016$) higher during DWR (81±20 L/min, 67±18% of VE max) as compared to IC training (55±18 L/min, 45±11% of VE max). However, lactate did not significantly differ between DWR (3.9±1.6 mmol/L; 43±22% of lactate max) and IC training (2.9±2.3 mmol/L; 33±30% of lactate max).
CONCLUSION: The present results showed that when training is calibrated by HR, the VO2 and VE are higher during DWR compared to IC. This might be related to smoothened chronotropic response in a context of lower limb hydrostatic compression increasing venous return and stroke volume. Regarding the fact that DWR training is less stressful for lower limb joints and can adequately stimulate the cardio-respiratory system, DWR can be proposed as an appropriate training for injured patients in recovery.

1 Glass & al., 1995
2 Foley & al., 2003
3 Simmons & Hansen, 1996
4 Miyoshu & al., 2004

IMPACT OF ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE ON ENDURANCE PERFORMANCE AND RUNNING BIOMECHANICS.

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UNIVERSITY OF LIEGE

INTRODUCTION: The occurrence of exercise-induced muscle damage (EIMD) can affect the running pattern and endurance performance. However, the EIMD-induced changes in biomechanical and physiologic parameters remain poorly understood. The aim of this study was to

examine the effects of a single isokinetic eccentric (ECC) exercise and ensuing Delayed-Onset Muscle Soreness on running biomechanics, muscle activity and physiologic measures during an exhaustive endurance run performed 48h later.
METHODS: Fourteen healthy, moderately active men completed two treadmill running tests (at 85% maximal aerobic speed) until exhaustion, with a week interval between both tests. The subject's running kinematics (using a 3D motion system), heart rate, pulmonary gas exchange, muscle activity and perceived exertion were recorded during both endurance tests (ETs). Forty-eight hours before the second test (ET2), participants were submitted to a bilateral isokinetic eccentric (ECC) protocol on the knee extensors. Indirect markers of EIMD were assessed before and 48h after the ECC exercise.
RESULTS: The ECC protocol induced EIMD as indicated by a significant increase in plasma CK (x12.52 ±33.15%), muscle pain (4.53±2.73a.u), a significant reduction in maximal isometric contraction (-19.54±14.75%) and in vertical jump performance (-17.94±17.19%, $p<0.01$). The running time to exhaustion was shorter (-29.30±24.10%, $p<0.05$) while the perceived exertion was higher (-10.1±s6.86%) for ET2 (with EIMD) compared to ET1 ($p<0.01$). The physiological data showed no significant difference between both ETs, except for the lactate level and heart rate measured at the end of the run which appeared significantly lower at ET2 ($p<0.05$). A higher step frequency (2.56±2.32%) coupled with a decrease in stride length (-2.51±2.4%) was observed during ET2 compared to ET1 ($p<0.05$). Articular amplitudes showed no significant differences between ETs although changes in the running pattern (i.e., vertical pelvis oscillation) were identified from the start to the end of both ETs ($p<0.05$). The electromyography data revealed increased muscle activity of the knee extensors during stance phase during ET2 but it did not reach significance.
CONCLUSION: Our data suggest that the knee extensors EIMD altered the running biomechanics and endurance performance without significative changes of the physiological parameters. Further investigations are required to explore whether the EIMD-induced biomechanical modifications are the result of pain perception or impaired muscle function.

CONVERSION OF VO2 TARGETS INTO EQUIVALENT LOADS FOR EXERCISE PRESCRIPTION AND TRAINING: VALIDATION OF A STRATEGY THAT ENSURES NOTHING IS LOST IN TRANSLATION

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INTRODUCTION: Aerobic exercise is medicine, able to induce specific health/fitness benefits in a dose-response manner. Adequate implementation of the intensity element of the exercise dose relies on the accurate conversion of oxygen consumption ($\dot{V}O2$) targets, typically derived from incremental testing (RI), into an equivalent external load for a constant work rate session (CWR). We recently proposed a strategy that, by accounting for the gap between the VO2/load relationships from the RI vs. the CWR, ensures that nothing is lost in the translation between these exercise paradigms. The evaluation of accuracy and precision of the above strategy outside of the original male-only sample is the aim of this study.
METHODS: 14 adults (7 females, 25 ± 3 yrs.) performed on a cycle ergometer a RI to detect the mean response time (MRT) and $\dot{V}O2$/Power output (PO) relationship in the moderate (i.e., GET and < respiratory compensation point (RCP)) domains of exercise. For each participant, a total of four intensity targets from the RI exercise paradigm ($\dot{V}O2RItarget$), two GET RESULTS: $\dot{V}O2CWR$ elicited in the heavy was significantly higher than the moderate-intensity trials (respectively 2602±588 and 1271±389 ml·min-1, $p<0.001$). These intensities corresponded to 68±5 and 34±8 %$\dot{V}O2max$ for the heavy and moderate domain, respectively. Independent of the intensity domain (main effect of interaction p=0.230), $\dot{V}O2CWR$ did not significantly differ from the intended metabolic target i.e. from $\dot{V}O2RItarget$ (main effect of exercise paradigm p=0.590). A very strong, significant correlation was found between $\dot{V}O2CWR$ and $\dot{V}O2RItarget$ (R2 = 0.98; $p < 0.001$), while there was a very small, not significant bias and small imprecision between measures ((bias -9.68ml·min-1; Z-score = 0.62; precision 115.19 ml·min-1).
CONCLUSION: Our data confirm that the correction strategy proposed by Caen K., based on individual MRT and domain-specific $\dot{V}O2$/PO correction coefficients derived from RI testing, maintains its accuracy and precision outside of the male-only sample used for the development of the method. This valid and time-efficient approach allows to identify the equivalent workload associated with a desired metabolic target, granting that the intensity element of the exercise dose will be appropriately implemented for training sessions in both the moderate and heavy domain of exercise.

CUT OFF VALUE IN PREDICTION OF SUCCESS IN TRIATHLON MIXED RELAY

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INTRODUCTION: The mixed team triathlon relay first occured in the program of the Olympic Games in Tokyo 2021. National teams of 4 triathletes compete with every athlete running the super sprint distance (300 m swim, 7km cycle and 1,5 km run) in the Women / Men / Women / Men order. Until now, only one conference paper enlight this event (Pöller, 2015) on one event race. Recent developments on WTCS relays increase the number of events and offers the possibility to analyze more races.
To determine which placements along the race lead to the podium, we investigated athletes time on every sequence of the races. As a result, it helps staffs optimizing the composition of their relay.
METHODS: The dataset come from the World Triathlon database, range from 2009 to 2021 and contains 12 280 entries for a total of 38 races and 56 national teams. International races i.e. World Championships, the World Triathlon Series Championship relay, the continental Championship and the Major Events are included. Records were divided into 4 groups according to the final ranking of the teams: "Winner" (rank 1), "Medalists" (rank 2-3), "Finalist" (rank 4-8) and "Finisher" (rank 9 & +). A transition matrix based on three discrete-time Markov processes was used to estimate the probability of winning the race, finishing on the podium (TOP3) and finishing among the TOP 8. The probabilities are estimated at each stage end of the relay without taking transition times into account, (i.e. 12 stages, 3 per athlete).
RESULTS: The results show an increase in the probabilitý of winning the race when triathletes rank first as the race progresses, starting at 28.9%. Similarly, for each group, the probabilities increase for triathlete that succeed at staying in their groups at the end of the race. For the Finisher group, we observe a strong decrease of the probability to be classified in the finalists, from the first triathlete, starting at 29,0%.
We notice that the probability to win the race increases for the first three triathletes in the swim stage, (6,6% at SwimLeg1 vs 17,1% at the SwimLeg2). As well as an increase in the probability of being on the podium when staying in the Top 8 until the third relay, BikeLeg1 16,3% vs BikeLeg2 18,0%.
CONCLUSION: These results highlight intrinsic specificities of the mixed triathlon relay. (i) the podium is not defined from the first relay but starting too far from the leading group condemns the team. (ii) Within a relay team, the first two triathletes seem to constitute a strategic role of placement while the last two triathletes are more likely to carry out solitary time trial type efforts. Time differences between posi-