UNIVERSITÀ di VERONA

PhD School in LIFE AND HEALTH SCIENCES

PhD Program in Neuroscience, Psychological and Psychiatric Sciences and Movement Sciences

Tuesday December 12th 2017

10:00-13:00, Aula 2 Gavagnin

Workshop: "Exercise tolerance: from functional indexes to individualised prescription"

Jan Boone, University of Ghent, Belgium

Gianluca Vernillo, University of Milan, Italy

Juan Murias, University of Calgary, Canada

Simone Porcelli, CNR Milan, Italy

Silvia Pogliaghi, University of Verona, Italy

The capacity to perform physical exercise of prolonged duration and adequate intensity (exercise tolerance) is essential to sustain effectively and independently the movement tasks related to work, leisure and activities of daily living and is a synthetic index of overall health. Furthermore, regular physical exercise has well-documented, dose-dependent, effects on maintenance and promotion of health throughout the life span. Therefore, the ability to acquire and adequate exercise "dose", has indirect effects on the quality of life and long-term health maintenance and is instrumental to health promotion throughout life. The clarification of the physiological mechanisms that affect exercise tolerance and their possible sensitivity to exercise interventions is central to the identification of specific, effective and applicable countermeasures to attenuate exercise intolerance and to improve health and quality of life across the life span.

In this workshop, we will present new data and insight on the physiological mechanism underpinning the reduction of movement economy as a function of exercise intensity and as a result of fatigue, contributing to exercise intolerance. Furthermore, we will present the concept of a landmark that demarcates heavy/sustainable from severe/unsustainable intensity domains and newly developed methods of measurement of exercise intensity boundaries. Finally, new data and considerations on the interchangeability of intensity indexes and their translation into a versatile and individualised exercise prescription will be presented, with a translational approach.

time	title	speaker
10:00-10:30	The VO_2excess: A loss of movement efficiency at high intensities during incremental exercise	Jan Boone
10:30-11:00	Neuromuscolar effects of acute muscle fatigue during running and their relationship with the running economy	Gianluca Vernillo
11:00-11:30	Laboratory-derived versus self-selected determination of critical intensities of exercise	Juan Murias
11:30-12:00	break	
12:00-12:30	Comparison between slow components of HR and $\dot{V}O2$ kinetics: functional significance	Simone Porcelli
12:30-13:00	Landmarks of exercise intensity: from measurement to individualised exercise prescription	Silvia Pogliaghi

Dr. Jan Boone, University of Ghent, Belgium

"The VO_2excess: A loss of movement efficiency at high intensities during incremental exercise"

Incremental ramp exercises are often used to assess exercise tolerance in healthy subjects and patient populations. The main advantage of this protocol is that four parameters quantifying exercise performance, i.e., VO_2 kinetics (Mean Response Time), VO_2max, intensity thresholds, movement efficiency, can be determined in a single test of relatively short duration. The slope of the relationship between VO_2 and work rate is used as a reflection of movement efficiency (i.e., delta efficiency). Surprisingly, it has been shown that the VO_2/work rate relationship shows an upward deflection from the linear relationship at the gas exchange threshold. This indicates that at a certain intensity the movement efficiency decreases, since each increase in work rate requires a greater amount of VO_2. This phenomenon has been termed the VO_2 excess and might have an impact on exercise tolerance. Therefore, it is important to have insight into the underpinning mechanism of the VO_2 excess in order to develop training and intervention guidelines to minimize the phenomenon, especially since it has been shown that in endurance trained individuals that the VO_2 excess is less pronounced.

Dr. Gianluca Vernillo, University of Milano, Italy

"Neuromuscolar effects of acute muscle fatigue during running and their relationship with the running economy"

Neuromuscular fatigue is defined as a reversible, time-dependent decline in the maximal force-generating capacity of a muscle. This type of fatigue can arise during and after running exercises leading to physiological and biomechanical changes that may affect the running economy and, ultimately, the running performance itself. Here, we discuss the physical and biochemical effects during and/or after prolonged running exercises that cause increased muscle damage as well as a greater neural input to the muscles and how the running economy can be affected. This two physiological phenomenon have been extensively investigated in a compartmentalized way. However, they are interrelated to each other. At the central level, they may cause a reduction of the neural input to the muscles; while peripherally they can act to deteriorate the efficiency of the contractile mechanism. This results in increased neural input to the muscle that would cause higher demands of O2 and, therefore, weakened running economy.

Dr. Juan Manuel Murias, University of Calgary, Canada

"Laboratory-derived versus self-selected determination of critical intensities of exercise"

From a research perspective, identifying the upper boundary of sustainable exercise is important to better understand the mechanisms that control the transitions from aerobic to anaerobic metabolism. Currently, the idea that critical power (CP) can be used as a measure that discriminates the limit between sustainable and unsustainable performance has gained much attention. However, although measures of CP should reflect the upper limit of metabolic stability, recent data has questioned the agreement between measures of CP and maximal lactate steady-state (MLSS). Thus, this presentation will discuss first the validity/utility of CP as a measure of sustainable performance in relation to the metabolic responses observed at MLSS. Finally, the idea that time-consuming laboratory measures such as CP and MLSS might be useful to study physiological responses to exercise, but add little value from a practical perspective will be introduced based on measures of self-selected performance.

Dr. Simone Porcelli, CNR Milano, Italy

“Comparison between slow components of HR and $\dot{V}O2$ kinetics: functional significance”

Aerobic exercise prescription is often based on a linear relationship between pulmonary oxygen consumption ($\dot{V}O2$) and heart rate (HR). The aim of the present study was to test the hypothesis that during constant work rate (CWR) exercises at different intensities the slow component of HR kinetics occurs at lower work rate and is more pronounced that the slow component of $\dot{V}O2$ kinetics, thereby negating the linear relationship mentioned above. Seventeen male (age 27±4 yr) subjects performed on a cycle ergometer an incremental exercise to voluntary exhaustion (to determine peak O2 uptake [$\dot{V}O2$peak] and the gas exchange threshold [GET]) and several CWR exercises: 1) moderate CWR exercises (MOD), below GET; 2) heavy CWR exercise (HEAVY), at 45% of the difference between GET and $\dot{V}O2$peak (Δ); 3) severe CWR exercise (SEVERE), at 95% of Δ; 4) “HR controlled” exercise in which work rate was continuously adjusted to maintain a constant HR slightly higher than that determined at GET. Breath-by breath $\dot{V}O2$, heart rate and other variables were determined. In MOD, no slow component of $\dot{V}O2$ kinetics was observed, whereas a slow component was observed for HR kinetics. During HEAVY, the amplitude of the HR slow component was more pronounced than that for the $\dot{V}O2$ slow component. During the HR-controlled exercise the decrease in work rate needed in order to maintain a constant HR was associated with a decreased $\dot{V}O2$. The HR slow component occurred at a lower work rate and was more pronounced than the V’O2 slow component. The absence of a linear relationship between HR and $\dot{V}O2$ during CWR at different exercise intensities has implications on exercise prescription and tolerance.

Dr. Silvia Pogliaghi, University of Verona, Italy

"Landmarks of exercise intensity: from measurement to individualised exercise prescription”

The administration of an appropriate exercise “dose” (i.e. duration and level of metabolic stress) relies on the individualised definition of metabolic intensity domains. Measurable landmarks demarcate exercise intensity domains. Among them, the critical intensity or threshold between heavy yet sustainable exercise and severe, unsustainable exercise (characterised by metabolic instability, decreased efficiency, fatigue and exercise intolerance) is a predictor of exercise tolerance and performance, is highly sensitive to training and provides an accurate, individualised basis for exercise prescription across different populations.

The literature contains numerous, confusing and inconsistent “thresholds”, defined in operational terms. We have recently demonstrated that many of these thresholds occur at an identical metabolic intensity, suggesting a common physiological mechanism and providing evidence for the interchangeability of methods. Furthermore, we have developed and validated two new “field” tests for critical intensity determination. The interchangeability of “threshold” indexes and the availability of newly developed valid, simple, submaximal, cost-effective and time-effective methods to determine critical intensity may provide exercise physiologists, sport scientists and clinicians with a number of options for determining and monitoring the limits of tolerable endurance exercise and for exercise prescription.

Finally, the correct translation of a metabolic intensity into an exercise load needs to account for the VO_2 kinetics and the loss of efficiency.