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LETTER TO THE EDITOR

Protocol for the Conconi Test and Determination of the Heart Rate Deflection Point

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Recently Ozcelik and Kelestimur (2004) have assessed the validity of the heart rate deflection point in the power output-heart rate relationship (Conconi test) for estimating the anaerobic threshold in different experimental conditions (normoxia and hypoxia). In their study, the tests were performed with an electromagnetically braked cycle ergometer at constant cadence with increments in power output obtained by increasing the pedalling resistance.

In cycle ergometry, modifications of the testing protocol give rise to modifications of neurohumoral and gas exchange responses (Gullestad *et al.* 1997), of power outputs at given respiratory exchange ratios (Amann *et al.* 2004) and modifications of the relationship between work rate, oxygen uptake and heart rate (Myers and Froelicher 1990). In this letter, we discuss the differences between the testing protocol used by Ozcelik and Kelestimur and the one developed by Conconi *et al.* (1996) and Grazzi *et al.* (1999).

Three points of the testing procedure used by the authors will be particularly considered.

1. The method used to increase power output

The testing protocol used by the authors (Ozcelik and Kelestimur 2004) was at fixed cadence, while in the test procedure developed by Conconi and co-workers (Grazzi *et al.* 1999) the increments in power output are obtained by increasing the pedalling frequency. As discussed specifically (Conconi *et al.* 1996, Grazzi *et al.* 1999), this testing procedure follows the physiological behavior kept by humans in performing incremental repetitive activities (e.g. running, walking, cycling, swimming) in which higher velocities are obtained by increasing both cadence and the force applied during each single movement (Stegeman 1981, Klentrou and Montpetit 1992). In cycling optimal cadence increases linearly with power output (Coast and Welch 1985, McIntosh *et al.* 2000) and cyclists reach pedalling frequencies up to 160 revolutions per minute during maximal efforts (Grazzi *et al.* 1999). High pedalling rates minimize stress and fatigue (Patterson *et al.* 1985, Patterson and Moreno 1990, Takaishi *et al.* 1996), reduce glycogen depletion (Ahlquist *et al.* 1992) and optimize force application on the pedals (Ericson and Nisell 1988, Takaishi *et al.* 1996).

The work rate increments at constant cadence adopted by Ozcelik and Kelestimur require more muscular power and lead to an early activation of the anaerobic glycolysis and exhaustion (Stegeman 1981, Green and Patla 1992, Widrick *et al*. 1992, Grazzi *et al.* 1999).

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2. The warm-up procedure employed

Warm up is designed to prepare the body for the ensuing sporting activities and to optimize performance, and consists of sport-specific exercises of increasing intensity lasting for at least 15 to 20 min (Renstrom and Kannus 2000). Proper warm up increases body temperature thereby accelerating the metabolic processes and optimizes muscular, cardiovascular, and metabolic adaptations to exercise (Bishop 2003). In addition, the power output at the anaerobic threshold is higher after warm up (Chawalbinska-Moneta and Hanninen 1989, Shimizu *et al.*1991).

A detailed procedure of the warm up necessary for the determination of the power output heart rate relationship has been described in details (Conconi *et al.* 1996, Grazzi *et al.* 1999).

The 4-min-low-intensity (20 watts) exercise used by the authors does not lead to an adequate warm up of the subject to be tested, which therefore cannot express his full aerobic performance in the subsequent test.

3. The method used to identify the heart rate break point

The authors do not indicate how the deflection point was identified. Observer and methods of detection can influence test results in anaerobic threshold identification (Shimizu *et al.* 1991). Objective mathematical methods avoiding subjective interpretations in this (Conconi *et al.* 1996, Grazzi *et al.* 1999) as well as others cases (Beaver *et al.* 1986) have been recommended.

An additional consideration deserves the low percentage of tests in which the heart rate deflection point was detected in the study of Ozcelik and Kelestimur (6 tests out of the 16 on which their study is based). When the cycling incremental test is performed following the procedure described in detail (Grazzi *et al.* 1999, not quoted by Ozcelik and Kelestimur), the heart rate deflection point is identified in the large majority of the cases. In the population examined, the heart rate deflection point was identified mathematically in 484 out of 500 and, in a second test, also in the 16 cyclists who were “unsuccessful” in the first attempt (Grazzi *et al.* 1999).

In conclusion, adequate warm up and increments in power output based on incremental cadence are necessary for the determination of the power output-heart rate relationship. Mathematical analysis of the data obtained allows the objective identification of the heart rate deflection point, a parameter useful both in sport and in clinical exercise testing.

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