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Editorial

Research publications linked with the analysis of time to exhaustion in cycling and the importance of laboratory tests

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1. Introduction

Field tests are increasingly used for evaluating cyclists nowadays, taking advantage of the availability of potentiometers in the market. It might be thought that laboratory tests are no longer useful and their results questionable. Since the end of the 1980s, many researchers have evaluated endurance performance in cyclists by using Tests to Exhaustion (TTE) in laboratories, which are also known as "Time Limit" tests (Tlim).

Although it is well known that performance in athletes is multifactorial and that a laboratory test at constant intensity does not guarantee real performance in the field, laboratory tests which analyse durability at specific physiological intensities offer high quality data for analysis, and subsequent modelling of the physiological performance profile of cyclists. In comparison to what happens at field tests, where there are countless uncontrollable variables (wind, temperature, humidity, drafting, changes in slope...), the TTE carried out in the laboratory guarantee a rigorous control of most of these variables. Published research results show, strong evidence which confirm a high inter-subject variability in TTEs, joined to high reproducibility (between-subject).

Only by using meticulous methodology in the laboratory, authors such as Coyle, Coggan, Hopper, & Walters (1988), were able to assert that the position of the first ventilatory threshold with respect to the VO_{2max} intensity allows to estimate the greater or lesser durability until exhaustion of a cyclist or athlete (i.e., the closer the first threshold is respect to the VO_{2max}, the higher is the TTE at VO_{2max} intensity). Likewise, unpublished data extracted from the research works link with the doctoral thesis of Lillo-Beviá, J.R. (2019), show evidence in cyclists of the inverse correlation between the position of either the Second Ventilatory Threshold (VT_2) or the Maximal Lactate Steady State (MLSS) intensities, with respect to the Maximal Oxygen Consumption (VO_{2max}) intensity, as an indicator of the TTE at VO_{2max} intensity (ie, the closer the MLSS or VT_2 is to VO2max, the higher is the TTE at the latter intensity).

2. Exercise intensity and time to exhaustion

To know the relative intensity at which an athlete or cyclists performs, but also the maximum amount of time that such intensity might be maintained, are two key factors in endurance training (Seiler, 2010; Stöggl & Sperlich, 2015). From this point of view, the knowledge of the between-subject and intra-subject variability of the TTE at any intensity, is an invaluable data to accurately determine the volume of training that can be tolerated, quantifying the workload and the related fatigue, as well as to predict performance in competition.

How long it is a cyclist able to keep pedalling at a certain intensity is inversely proportional to this intensity. The relationship between power or speed and time to exhaustion has been repeatedly analysed in the scientific literature since the early 1990s and even earlier (Billat et al., 1996; Veronique Billat, Renoux, Pinoteau, Petit, & Koralsztein, 1994; Coyle, Coggan, Hemmert, & Ivy, 1986; Coyle et al., 1988; Billat et al., 1996). To provide information to the readers of this article, some summarizing tables were published in this author's doctoral thesis (Lillo Beviá, 2019), where between-subject, but also within-subject variability were described. All papers published are related with the TTE in different representative physiological events of the aerobic-anaerobic transition (Skinner & McLellan, 1980), based on the existence of two vital points in said transition, called "first threshold" (Kindermann W, Simon G, 1979) and "second threshold" (Wasserman & McIlroy, 1964). These two points are justified by the changes in energy metabolism, blood lactate concentration, acid-base balance and, related to all this, the regulation of ventilation (Skinner & McLellan, 1980), being these authors who proposed what they called the “Triphasic Model”. Besides, TTE at Maximal Lactate Steady State (MLSS) (Beneke, 2003) were also included. This event was based on the evidence described in 1930 by Owles WH. (1930) and in the existence of a single and unique intensity in which the concentration of plasmatic lactate underwent a progressive increase (called the Owles point). Finally, some additional research TTE works were included, at different intensities between the second ventilatory threshold (VT_2) and the MLSS.

To sum up, it must be highlight that the largest number of TTE research publications has been carried out at PAM or VO_{2max} intensities. Probably due to the differences in the protocols to determine the first power that produces the VO_{2max} plateau (that is, the Maximum Aerobic Power), the TTE results reported by these investigations show wide differences between them, ranging from 03:23 ± 00:45 (Pallarés, Lillo-Bevia, Morán-Navarro, Cerezuela-Espejo, & Mora-Rodriguez, 2020), up to 06:24 ± 01:06 mm:ss (Caputo, Mello, & Denadai, 2003).

Regarding TTE in VT_2, to the best of this author knowledge, only 3 research papers have been published (Table 2). The results agree that the TTE lasts between 10 and 20 minutes.

Finally, and writing about the durability at the MLSS intensity, results show that results range from 37:42 ± 08:54 ((Fontana, Boutellier, & Knoepfli-Lenzin, 2009) to 76:05 ± 13:53 (Pallarés et al., 2020).

An in-depth and thorough analysis of each work should be done to understand why there are differences in ETT results (i.e. quality of ergometers, fitness of subjects, cadence protocols, completion criteria, etc.).

Not only the TTE value must be considered but also the intra-subject variability (relative reliability) of those TTE. Only a few research studies have analysed this point in cycling so far (Costa, Matos, Pertence, Martins, & Lima, 2011; Faude et al., 2017; Jeukendrup, Saris, Brouns, & Kester, 1996; Laursen, Shing, & Jenkins, 2003; McLellan, Cheung, & Jacobs, 1995; Pallarés, Lillo-Bevia, Morán-Navarro, Cerezuela-Espejo, & Mora-Rodriguez, 2020; Higgins, James, & Price, 2014). It is important to highlight how important is that performance has a small intra-subject variability when a test is repeated. It means that this performance might be considered reliable (Hopkins, 2000). If the TTE at the specific intensity of a given physiological event or intensity were highly variable on consecutive days for the same individual, it would mean that the same absolute load could be producing different metabolic demands and cardiorespiratory adaptations, without changing their physical condition.

3. Conclusion

As a conclusion, it seems sensible to establish that TTE in laboratories for each cyclist and for each specific physiologic event, involves a very high cost in human resources, time, and materials, as well as been highly demanding for cyclists from the physiological and physiological point of view. These facts preclude its widespread use for most of them. However, it is also evident that although the use of potentiometers in the field and the analysis of power profiles based on specific times represent the future, it must be recognized that, without the basic research carried out in laboratories around the world during the last three decades, this future would lack of the sufficient scientific support.

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