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Comparison of the World and European Records in the 100m Dash by a Quasi-Physical Model

Tiago M. Barbosa[a,b,c*], Pedro Forte[c,d], Daniel A. Marinho[c,d], Victor M. Reis[c,e]

[a]*Nanyang Technologic University, 637616 Singapore, Singapore*
[b]*Polytechnic Institute of Bragança, 5300 Braganca, Portugal*
[c]*Research Centre in Sports, Health and Human Development, 5001 Vila Real, Portugal*
[d]*Univesity of Beira Interior, 6200 Covilha, Portugal*
[e]*Univesity of Trás-os-Montes and Alto Douro, 5001 Vila Real, Portugal*

Abstract

The aim was to employ a quasi-physical model to analyse the performance and biomechanics of the World and European records at the 100m dash in Athletics. At the time of this research, the World record was hold by Usain Bolt (Jamaica) with 9.58s and the European record 9.86s by Francis Obikwelu (Portugal). The analysis of the performance employs a quasi-physical model that feature the drive, maintenance, velocity and drag terms. Obikwelu showed a slower start (drive term) and Bolt a lower rate of deceleration over the race (propulsive term). The velocity and drag terms were higher for Bolt. Correcting the race time for a hypothetical null wind speed, Bolt´s time would have been 9.62s (i.e. a 0.04s impairment) and 9.89s for Obikwelu (i.e. a 0.03s impairment).

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1. Introduction

Olympic Games, World and European Championships are major events in Athletics. In these events, most athletes have a large net of support, including sport scientists and amid these ones, biomechanists. Sport scientists aim to provide analytic data to athletes on their performances, as well as, their direct competitors [1,2,3]. In competitive settings, such as Olympic Games and World Championships, science staff at most national teams deliver yet to athletes reports on their kinematics. However, in the literature we can find other approaches that can be used concurrently providing a deeper insight. Sports scientists and researchers are also able of employing quasi-physical models and other analytical procedures to help the athletes [1] in competition settings. The major goal is providing to athletes and coaches insightful and holistic details on their performance but selecting testing procedures that are straightforward and less time-consuming.

The analysis of the performance by quasi-physical models is one of the most interesting procedures that can be carried out [1]. As far as we understand, the comparison of the performances delivered by the World (Usain Bolt) and European (Francis Obikwelu) record holders in the 100m dash has not yet been reported. The breakdown of the performance into its main determinant factors (i.e. terms in the model) can provide the insights pointed out earlier on.

The model reported by Mureika [1] features four terms considered as determinants for the final race time. The drive and maintenance terms describe the sprinters performance over such phases of the race. I.e., the beginning right after the start when he aims to reach as quickly as possible the maximal speed and the upright position (drive phase). After a brief transition eventually the sprinter tries to keep the maximal speed as long as possible, avoiding a speed decay due to fatigue (maintenance phase). However, there is a human limit to reach such maximal speed, being reflected by the speed term. Another term in the

* Corresponding author. Tel.: +65-6219-6213; fax: +65-6896-9260.
E-mail address: tiago.barbosa@nie.edu.sg

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model reflecting the resistance acting upon the sprinter is the drag term. Altogether, these four terms can be used to have some insight on key-moments of the race and how it might affect the sprinter´s performance. Therefore, this quasi-physical model can provide practitioners and athletes a comprehensive understanding of their performance in the 100m dash. Besides anthropometrical features, all that is need is to collect the instantaneous speed over the race. Upon that the model [1] as reported under methods is run.

The aim was to employ a quasi-physical model to analyse the performance and biomechanics of the World and European records at the 100m dash in Athletics. It was hypothesized that significant differences could be identified between both sprinters in key-moments of the race, such as the drive and maintenance phases, explaining the lag in the race times between the two of them.

2. Methods

2.1. Sample

The sample was composed by the World and European record holders of the 100m dash at the time of this research. The World record is held by Usain Bolt (1.96m of height, 94kg of body mass; data retrieved online) of team Jamaica with the time of 9.58s (wind: +0.9m/s) obtained at the Berlin 2009 World Championships (Gold medal). The European record is held by Francis Obikwelu (1.95m of height, 80kg of body mass; personal communication by the athlete) of team Portugal with the time of 9.86s (wind: +0.6m/s) at the Athens 2004 Olympic Games (Silver medal). All procedures carried out in this research are in accordance to the Declaration of Helsinki.

2.2. Quasi-physical model

The performance in the 100m dash is determined by the time (t) spent over such displacement (d) and hence, under influence of the velocity:

$$t = \frac{d}{v} \tag{1}$$

The sprinter must reach his maximal speed (or velocity that for this matter have the same magnitude) as soon as possible. I.e., the acceleration (a) is determined by the second law of motion, having the mechanical force (F) and the inertial component (i.e. mass, m) as exogenous variables:

$$a = \frac{F}{m} \tag{2}$$

The F can be broken down into propulsive (F_{prop}) and resistive forces (F_{resist}). So, equation 2 is expended to:

$$a = \frac{(F_{prop} - F_{resist})}{m} \tag{3}$$

According to the quasi-physical model selected the F_{prop} encompasss the drive (f_s) and the maintenance terms (f_m), whereas the F_{resist} feature the velocity (f_v) and drag terms (f_d) [1]:

$$a = \frac{\left[(f_s + f_m) - (f_v + f_d)\right]}{m} \tag{4}$$

Speed-time [v(t)] or speed-distance [v(d)] of both races were retrieved online and from technical reports [4]. The mainstream devices to collect this data are Laser apparatus, Doppler systems, video cameras or time gaits. However it is also found in the literature pieces of research reporting kinematic analysis after retrieving publicly-available online material [5].

The f_s is related to the start, from the crunched to the vertical position, considering the starting magnitude (f_o=6.10N/kg) and constant σ (2.22s^{-2}):

$$f_s = f_0 \exp(-\sigma \cdot t^2) \tag{5}$$