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O2o. Analysis of the resistive forces acting on a world-ranked wheelchair sprinter at different speeds

Pedro Forte^{1,3}, Daniel A Marinho^{2,3}, Jorge E Morais^{2,4}, Pedro G Morouço⁵, Eduarda Coelho^{3,6}, Tiago M Barbosa^{3,4,7}

1. Higher Institute of Educational Sciences of the Douro, Penafiel, Portugal; pedromiguel.forte@iscedouro.pt; 2. University of Beira Interior, Covilhã, Portugal; 3. Research Centre in Sports Sciences, Health and Human Development, Portugal; 4. Polytechnic Institute of Bragança, Bragança, Portugal; 5. Polytechnic Institute of Leiria, Leiria, Portugal; 6. University of Trás-os-Montes e Alto Douro, Vila Real, Portugal; 7. Nanyang University Technology, Singapore

INTRODUCTION

The main resistive forces (RF) in wheelchair racing are rolling resistance (RR) and aerodynamic drag (D) (Barbosa et al., 2016; Forte et al., 2018). Typically, a T52 wheelchair sprinter reaches an instantaneous maximal speed of about 7m/s (Barbosa & Coelho, 2018). However, in a 100m sprinting event, the athlete only reaches a speed over 6 m/s after the 30m mark (Barbosa & Coelho, 2018). The contribution of the RR and D to overall RF in wheelchair racing is yet unclear (Barbosa et al., 2016). Thus, the aim of this study was to assess the partial contributions of RR and D to RF at different speeds by computational fluid dynamics (CFD) and analytical procedures.

METHODS

A male world-ranked wheelchair sprinter was recruited for this research. All procedures were in agreement to Helsinki's declaration. The Artec Scanner was used to obtain the subject 3D model in the racing position. Fluent CFD software measured the effective area at 2.0, 3.5, 5.0 and 6.5 m/s. Then, effective area was calculated. A 3.0x2.0x1.5m domain was meshed with 35 million of prismatic elements on the Ansys meshing module (Ansys Meshing 16.0, Ansys Inc., Pennsylvania, USA). The D and RR were computed as (equation 1 and 2):

$$D = 0.5 \rho A C_d v^2 \quad (1)$$

Where ρ is the air density (1.203 kg/m³ at 15° C), $A C_d$ is the effective area and v the velocity.

The RR was estimated by an analytical procedure:

$$RR = \mu R \cdot m \cdot g + k_f \cdot m \cdot g \cdot v^2 \quad (2)$$

Where, m was the mass, g gravitational acceleration and v the velocity. The μR and k_f are the rolling friction coefficients for linear and non-linear velocity dependency, respectively. The μR and k_f were assumed to be 0.01 and 5×10^{-6} respectively.

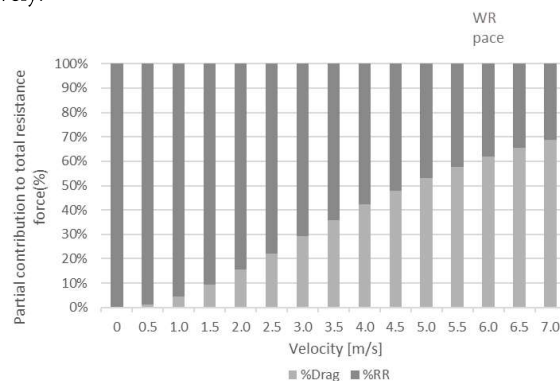


Figure 1. Partial contribution of Drag and rolling resistance (RR) to total resistance forces at different velocities in wheelchair sprinting.

RESULTS

From 0 to 7m/s, the D ranged between 0% and 70%, whereas RR from 100% to 30% (Figure 1). At the world record pace (6.08 m/s), the D contribution was about 60%.

CONCLUSIONS

The athletes might be aware that at speeds over 5 m/s the Drag is the main RF, outweighing the partial contribution by RR. Hence, in the first fifth of a 100m race (i.e. by 20m mark) the key resistance force is

RR; conversely in the second stretch it is Drag. Therefore, wheelchair sprinters should implement different strategies to minimize both RR and Drag.

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