Balducci P, Clemencon M, & Hautier C. "Relatively" Slow and Steady Wins the Race.
J Sport Human Perf 2016; 4(4):1-6

JOURNAL OF SPORT AND HUMAN PERFORMANCE

SHORT REPORT OPEN ACCESS

"RELATIVELY" SLOW AND STEADY WINS THE RACE

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ABSTRACT

Do variations in segment speed (e.g. pacing) on a mountain ultramarathon relate to performance? An index of pacing (IP) was calculated by dividing the average race speed by the speed on the first race segment. In addition, segment speed and coefficient of variation (CV) in speed were analyzed for seven race segments.

The two methods were related to race time and strongly correlated with each other. Speed in a mountain ultramarathon varies widely, but the best performances are achieved by the best pacers.

Keywords: exercise performance; pacing; endurance training

INTRODUCTION

Investigating the physiological and biomechanical modifications associated with long distance events has become a popular subject to study in recent years. [1-3]. Nevertheless, literature about factors that play a critical role in final performance is scarce. Despite the very low intensity of running in mountain ultramarathons, Lazzer, Salvadego [4] noted that performance still relies on maximum oxygen uptake ($\dot{V}O_2$max) and fraction (F) of $\dot{V}O_2$max sustained. This is in line with di Prampero, Atchou [5] who found that the average running velocity on long distance is directly proportional to $\dot{V}O_2$max, F, and inversely proportional to energy cost of locomotion (Cr). Millet, Hoffman [6] proposed a synthetic scheme of performance factors in mountain ultramarathon (MUM), in which maximal sustainable power, running and walking Crs, psychological and motivational factors, are the three primary factors that determine performance. However, pacing is not included in this study. Pacing has been investigated primarily for road races [7-9] and these studies demonstrated that the best performances are achieved with less variation in speed. Concerning pacing in MUMs, the literature is scarce and contradictory. Hoffman [10] examined pacing among the most successful runners of the Western States Endurance Run (WSER). He noted that mountain trail running is characterized by wide variations in speed, but that the fastest times are achieved when speed fluctuations are limited. However, Kerhervé, Cole-Hunter [11] found no correlation between overall performance and descriptors of pacing on a 173-km MUM.

On a MUM, maintaining a consistent pace is challenging due to wide variations in terrain (ascent, descent, ground-surface conditions), temperature, weather and lighting conditions, and the evolution of fatigue.

These variations also make comparisons between races difficult. Thus, the relationship between pacing and performance in MUMs should be studied on different races and on larger groups.

The aim of the present work was to examine pacing among the first 30 male runners on the Interlacs Trail. We hypothesized that finish time is related to pacing among a large group of endurance runners.

METHODS

The Interlacs Trail race took place in Aix-les-Bains (France) in May 2016. It is a regional level race, initiated in 2015, with 196 finishers this year. The course was 75 km long with a total positive elevation of +3930 m and a total negative elevation of –3700 m (Figure 1). It is a point to point race between Duingt and Aix-les-Bains. The race started at 5:00 a.m. The temperature at the highest point of the race (1640m) was 4°C; the maximum temperature, 20°C, was reached at 14:00.

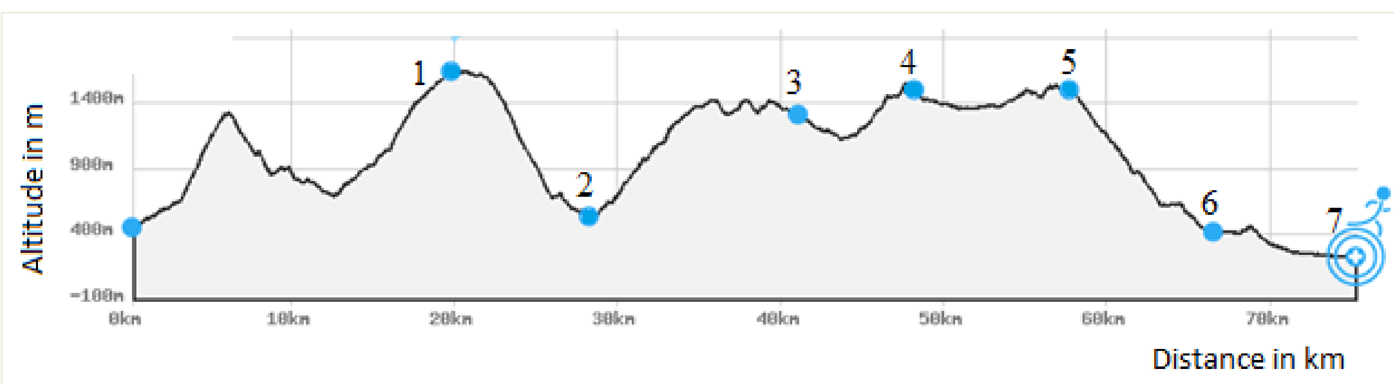
An index of pacing (IP) was calculated by dividing the average speed of the entire route by the average speed on the first section (19.7 km and 1912 m of cumulative elevation gain) (Figure 1 and Table 1). The flat equivalent speed (equation 1) was used, based on a theoretical relationship between elevation and energy expenditure (i.e., adding 1 kilometer of distance for each 100 m of elevation gain) [1].

$$flat\ equivalent\ speed = \frac{\text{real distance(km)} + \frac{d^{+}}{100}}{time\ (h)}$$

with d^{+} = cumulative elevation gain in meters

Segment speeds and coefficient of variation (CV) in speed were also analyzed for seven race segments (Figure 1 and Table 1). CV in speed was determined by dividing the standard deviation of the segment speeds by the mean speed of each runner. Data were provided by the Live Trail system, a real-time race management system. The runners wore an electronic chip which was read at the start, at the various checkpoints, and at the finish. The runners' data is transmitted in real-time at these points via GSM, satellite, or WiFi on an Internet server.

Figure 1: *Interlacs trail profile (altitude in m / distance in km), with the eight timing points represented by bullets. Used by permission of Live Trail*



ISSN: 2326-6333

Table 1. *Data about Interlacs Trail: distance and elevation of each segment, flat equivalent segment distance and cumulative distance, mean real speed and mean flat equivalent speed of the first 30 male runners.*

Parameters/timing points	1. Start-Semnoz	2. Semnoz-Pont de l'Abime	3. Pont de l'Abime - La Plate	4. La Plate - Revard 1	5. Revard1 - Revard 2	6. Revard2 - Mouxy	7. Mouxy -Arrival
segment distance (km)	19.6	8.5	12.8	7.2	9.5	8.8	8.7
segment elevation (m)	1912	70	1136	441	270	43	57
Flat equivalent segment distance (km)	38.7	9.2	24.2	12.6	11.2	9.2	9.4
Flat equivalent cumulative distance (km)	38.7	47.9	72.1	84.7	95.9	105.1	114.5
Mean real speed ($km.hr^{-1}$) ± SD	6.88 ± 0.66	9.48 ± 1.05	6.33 ± 0.81	6.48 ± 0.95	7.70 ± 1.02	9.98 ± 1.62	10.15 ± 0.95
Mean flat equivalent speed ($km.hr^{-1}$) ± SD	13.58 ± 1.31	10.15 ± 1.12	11.97 ± 1.52	11.34 ± 1.66	9.08 ± 1.21	10.44 ± 1.69	10.85 ± 1.01

Statistical Analysis

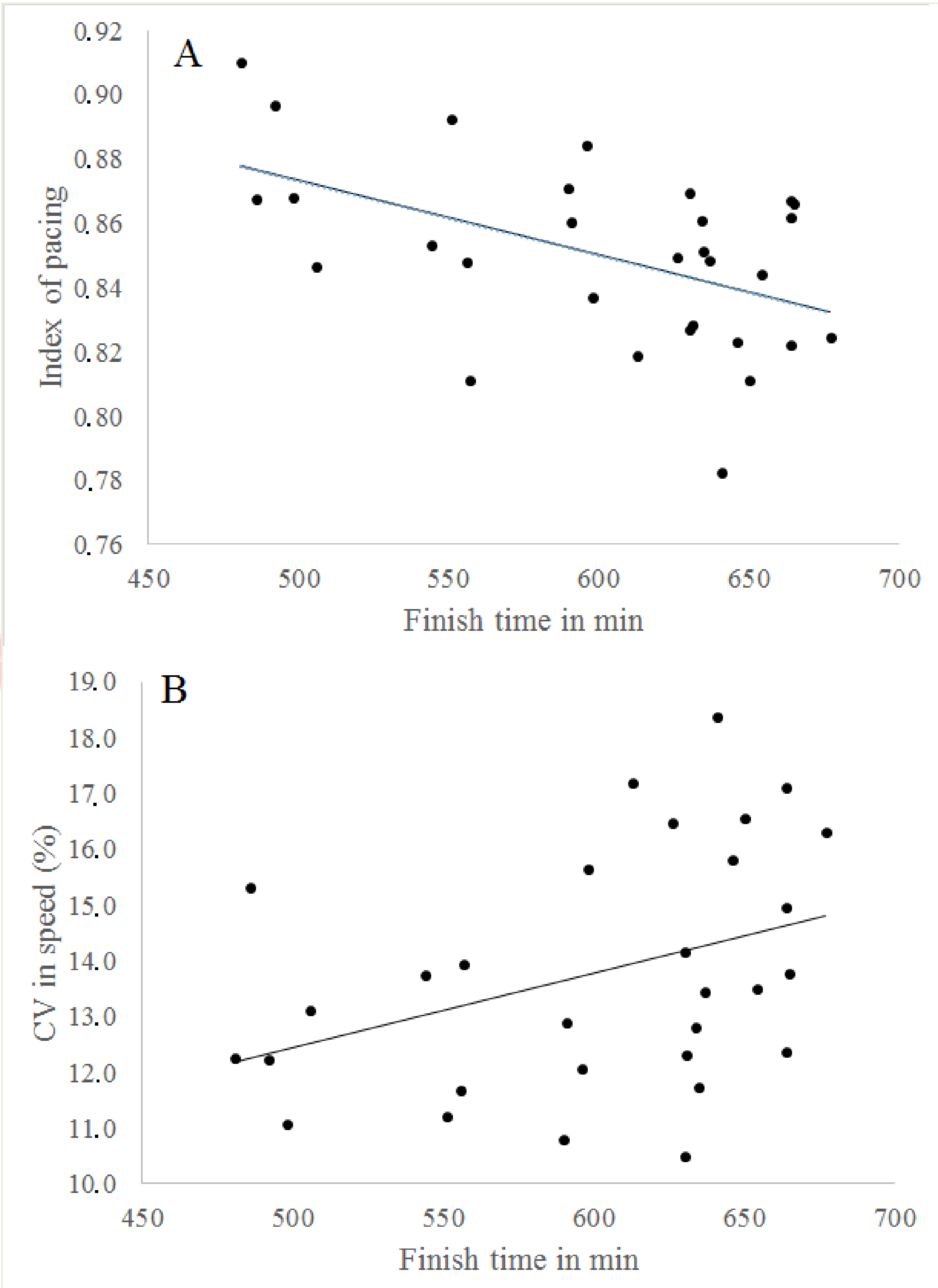
Data are expressed as a mean ± standard deviation. Results were tested for normal distribution using the Shapiro-Wilk W test. The range of each variable was indicated. Pearson's product moment correlation coefficient (r) with 95% confidence interval (CI) was used to examine the relationships between selected parameters. Statistical significance was set at $p < 0.05$.

RESULTS

The mean performance of the first 30 runners was 600 ± 60 min (range 481 to 677 min). The average IP was 0.85 ± 0.03 (range, 0.78 to 0.91). Mean CV in speed was 13.8 ± 2.1 (range 10.8 to 18.4).

The two methods used to evaluate pacing are strongly correlated ($r = -0.66$, $p < 0.001$). IP ($r = -0.51$, $p < 0.01$) and CV in speed for the seven race segments ($r = 0.38$, $p < 0.05$) were both related to finish time (Figure 2 A, B). Interestingly, the winner of the race obtained the best IP.

Figure 2: Correlations between index of pacing and finish time (A), and coefficient of variation (CV) in speed and finish time (B)



ISSN: 2326-6333

DISCUSSION

Mean coefficient of variations in speed and index of pacing showed significant fluctuations in speed on the Interlacs Trail. Although comparisons between different MUM races is difficult, results in CV in speed support the findings of Hoffman [10]. In addition, correlations between pacing and performance showed that a faster finish time is attained by less fluctuation in speed. These findings show that pacing is a factor of performance for MUMs. Such a correlation between performance and pacing is surprising considering that variations in slopes and ground-surface conditions greatly influence running speed. The stronger correlation found between IP and performance suggested that controlling running speed on the first portion of the race led to a faster final time.

Another aspect of a conservative pacing strategy is the minimization of speed loss throughout the race. Considering that the last section of the studied event was 17.5 km long with a total descent of 1250m, the final running speed surpassed all the others section running speeds, understating the expected speed reduction. Unfortunately, the method proposed by Saugy, Place [1] did not account for the negative cumulative elevation in the calculation of the flat equivalent speed, making a comparison impossible. Whatever the limits, the significant relationship observed between CV in speed and performance is in line with previous studies [10, 12], which demonstrates the validity of this method. Nevertheless, the results are strictly limited to the analysis of the top 30 runners of this specific race.

In conclusion, the best performances are achieved when runners start at a low intensity relative to their mean race speed and use an even pacing strategy. Athletes and coaches should take these results into account to enhance performance for such events.

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ISSN: 2326-6333