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# Evaluation of time to exhaustion in ascent running

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## Résumé

### Introduction

Running velocities at various training intensities are commonly prescribed as percentages of Maximal Aerobic Speed (MAS) (1). MAS reflects the external load while being closely linked to internal physiological responses - most notably, oxygen consumption. MAS is commonly estimated using a 6' all-out run, with average speed serve as the estimation.

The rise of trail running has increased interest in the demands of uphill training. Differences in internal training load between level and uphill running suggest that distinct metrics are needed to accurately monitor and prescribe training on slopes. Due to the vertical displacement during uphill running, Maximal Aerobic Ascent Speed (MAAS), measured in vertical m.h-1, is a more appropriate metric than MAS when slope comes steeper than 15-20% (2). However, the link between MAAS and time to exhaustion in uphill running is unknown, raising doubts about the relevance of the 6' all-out test for estimating MAAS.

This study aimed to investigate running time to exhaustion at MAAS on a 25% slope (MAAS25%) and to explore a simple method for estimating MAAS25%. We hypothesized that 1) time to exhaustion at MAAS25% would be shorter than at MAS on level condition; 2) a 4' maximal-effort run on a 25% slope could provide a practical estimation of MAAS25%.

### Method

Fifteen male runners (age  $37.07 \pm 8.48$ y, weight  $71 \pm 7.18$ kg, height  $177.87 \pm 7.46$ cm) completed all tests under both level and slope conditions in a randomized order. For the level condition, a VAMEVAL test assessed MAS, followed 48 hours later by a time-to-exhaustion test at MAS and a 6' all-out test on a track. For the slope condition, an Incrementrail test (3) have been performed outside on regular 25% ascent to estimated MAAS25% followed 48 hours later

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\*Intervenant

by a time-to-exhaustion test at MAAS25% and a 4' all-out test on the same incline. A T-test was conducted to compare time to exhaustion at MAS and at MAAS25%. Additionally, a T-test and a Bland–Altman plot were used to compare MAAS25% with the 4' all-out speed.

## Results

Time to exhaustion at MAS and MAAS25% was  $5.98 \pm 0.75$  and  $3.74 \pm 0.56$  minutes, respectively, and were found to be different ( $T = -9.28$ ,  $p < 0.001$ ). The difference between MAAS25% and the average velocity obtained from the 4' all-out test at 25% was  $-20 \pm 41$   $\text{m} \cdot \text{h}^{-1}$ . No difference was found between MAAS25% and the 4' all-out velocity ( $T = -1.68$ ,  $p = 0.12$ ), with all differences in the Bland–Altman plot falling within the limits of agreement ( $-111.06$ ,  $73.72$ ).

## Discussion

Time to exhaustion during uphill running at a 25% incline at MAAS25% is approximately 3 minutes and 44 seconds, which is shorter than the 6' duration typically recommended for the all-out test used to estimate MAS on level condition. This can be explained by the fact that running on a 25% slope imposes greater oxygen consumption because 1) Uphill running requires moving the body's center of mass upward against gravity; 2) Running on gradients steeper than 15% eliminates the bouncing mechanism and reduces the use of elastic energy, both of which normally aid vertical propulsion (2).

The average velocity derived from the 4' all-out test was not significantly different from the MAAS25%, and showed good agreement with values obtained from the Incremental Trail Test. A 4' all-out test on 25%-slope treadmill may then represent a practical and effective approach for estimating MAAS25%.

## Conclusions-Perspectives

Time to exhaustion during uphill running at a 25% incline at MAAS25% appears to be shorter than during level running at MAS. Therefore, the all-out test used to estimate MAAS25% should be performed over a shorter duration than that used for estimating MAS on level condition. Our results showed that a 4' all-out effort appears to provide a relevant estimation of MAAS25%.

## References

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