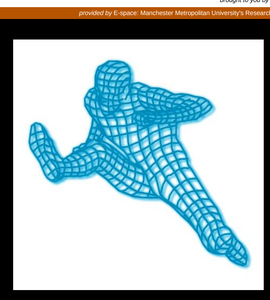
# THE RELATIONSHIP BETWEEN MAXIMAL LACTATE STEADY STATE VELOCITY, CRITICAL VELOCITY, AND THE VELOCITY AT THE LACTATE TURNPOINT.



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## INTRODUCTION

In cycle exercise, it has been suggested that the critical power and the maximal lactate steady state, demarcate the transition between the heavy exercise domain (in which blood lactate is elevated above resting values but remains stable over time) and the very heavy exercise domain (in which blood lactate increases continuously throughout constant-intensity exercise) (Poole, et al., 1988). Furthermore, some studies have suggested that the 'lactate turnpoint' (the 'second threshold' increase in blood lactate observed during an incremental exercise test) provides a close estimate of the MLSS (Aunola and Rusko, 1992).

Therefore, it appears that the critical power may provide a non-invasive method for assessing the power output at the maximal lactate steady state (MLSS). To our knowledge, previous research has not comprehensively investigated whether this is also true for other modes of exercise such as running.

### AIM

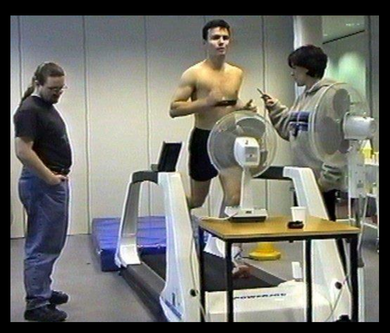
The aim of the present study, was to compare the critical velocity (CV) with the velocity at the maximal lactate steady state (V-MLSS) and the velocity at the lactate turnpoint (V-LTP) during treadmill running.

## METHOD

### SUBJECTS

Eight male subjects

- *Age 28 ± 5 years*
- *Body mass 71.2 ± 8.0 kg*
- *$VO_2$ max 54.9 ± 3.2 ml.kg.$^{-1}$min$^{-1}$*



The subjects were active in recreational sports activities, and were familiar with treadmill running, exercise physiology laboratory procedures, and exercising to exhaustion.

All subjects gave written informed consent to participate in this study which was approved by the Institutional Ethics Committee.

### PROTOCOLS

The subjects completed a maximum of 10 laboratory sessions: an initial incremental treadmill test to determine lactate threshold (LT), lactate turnpoint (LTP), and maximal oxygen uptake ($VO_2$ max), and 8-9 subsequent sessions to determine CV and MLSS.

Coded plots of blood [lactate] against running speed were presented to two independent reviewers for assessment of the running velocities at the lactate threshold (V-LT) and the lactate turnpoint (V-LTP). The V-LT was defined as the running velocity at which the first sustained increase in blood [lactate] above baseline was observed (Wasserman et al. 1973). The V-LTP was defined as a sudden and sustained increase in blood lactate at ~ 2.5 - 4.0mM, detected using log-log transformations of the lactate-velocity data between LT and $VO_2$ max.

The subjects returned to the laboratory on 8-9 occasions for determination of CV and MLSS. The CV and MLSS testing sessions were presented in blind random order and completed on separate days within a 3 week period.

The CV was determined from 4 treadmill runs at velocities that were chosen to result in exhaustion within 2-12 minutes; CV was calculated as the slope of the regression equation relating total distance covered to time to exhaustion.

The MLSS was determined from 3-5 treadmill runs of up to 30 minutes duration at velocities spanning the V-LTP in increments of 0.5 km.h$^{-1}$; the running velocity at MLSS (V-MLSS) was defined as the highest velocity at which blood lactate increased by no more than 1.0 mM between 10 and 30 minutes (see Figure 1).

The data were analysed using a one-way ANOVA, and Pearson product moment correlation coefficients, with statistical significance accepted at $p < 0.05$. The bias and the limits of agreement between the three parameters were also calculated (Bland and Altman, 1986).

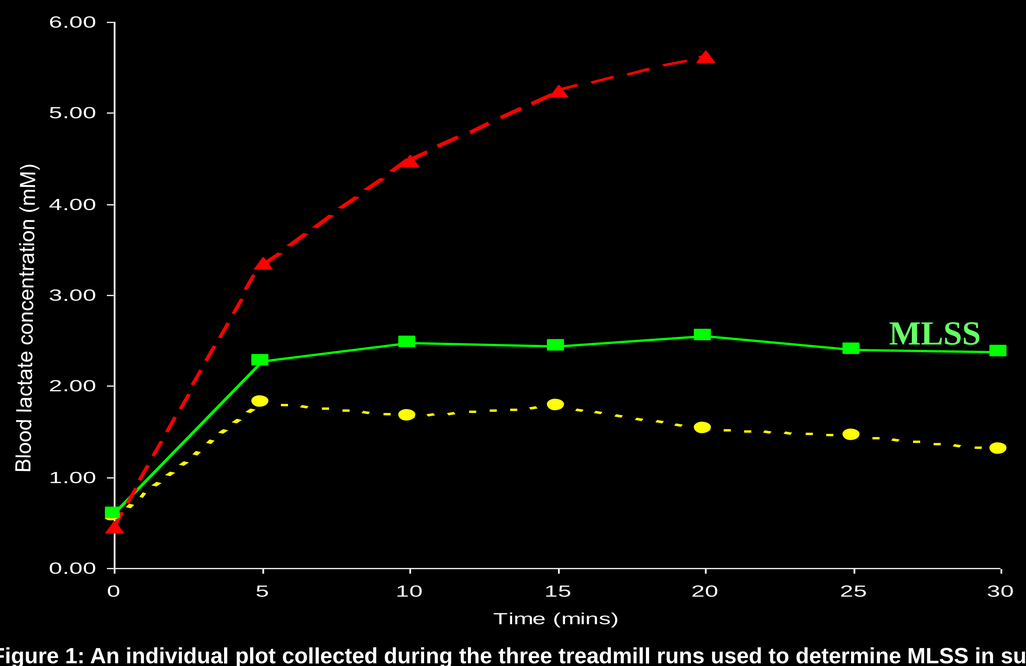



Figure 1: An individual plot collected during the three treadmill runs used to determine MLSS in subject 5.

## RESULTS

The ANOVA revealed no significant differences between CV (14.4 ± 1.1 km.h$^{-1}$), V-MLSS (13.8 ± 1.1 km.h$^{-1}$) and V-LTP (13.5 ± 0.5 km.h$^{-1}$), and the three variables were strongly inter-correlated ($r = 0.63 - 0.77$; $P < 0.07$). The CV, V-MLSS and V-LTP occurred at 89 ± 4, 86 ± 4, and 84 ± 6 % $VO_2$ max respectively ($P > 0.05$).

However, the bias ± 95 % limits of agreement for comparisons between CV and V-MLSS (0.6 ± 2.2 km.h$^{-1}$), CV and V-LTP (0.9 ± 2.7 km.h$^{-1}$), and V-MLSS and V-LTP (0.3 ± 1.8 km.h$^{-1}$) suggest that the extent of disagreement was too great to allow one parameter to be accurately estimated from another in individual subjects (see Figure 2).

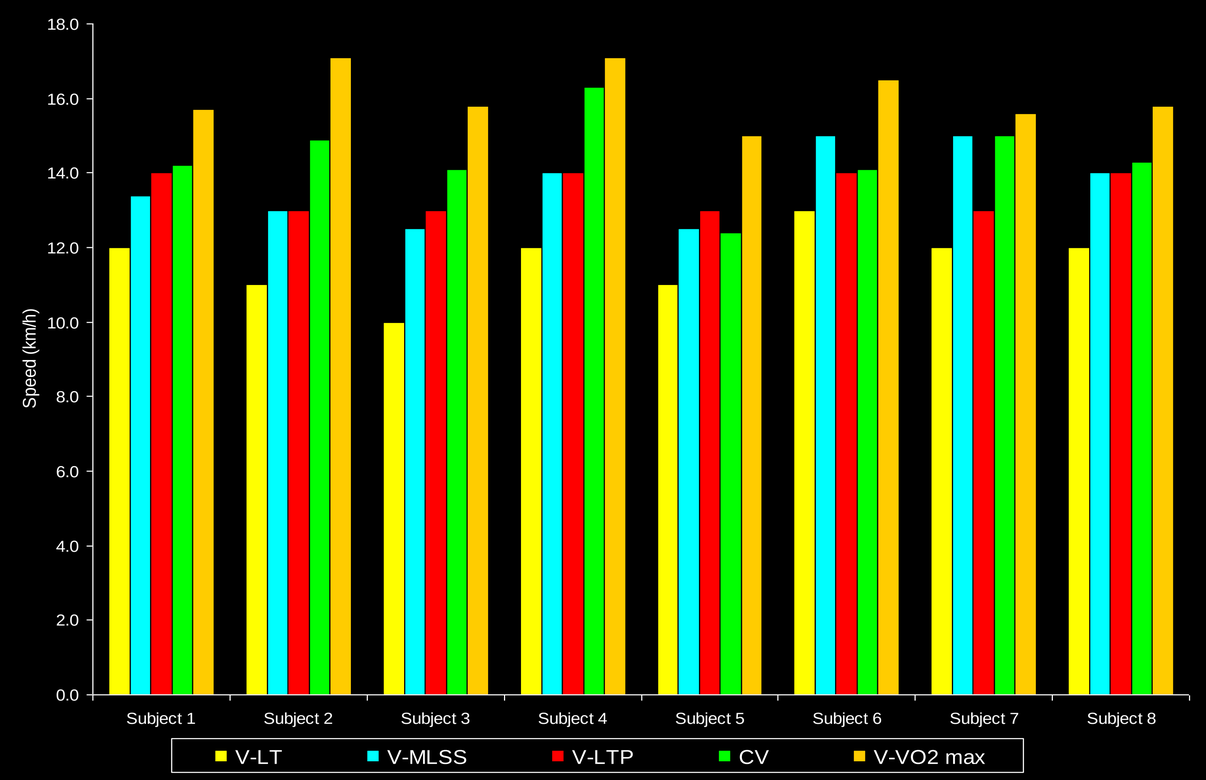



Figure 2: Individual running velocity data associated with LT, LTP, MLSS CV and $VO_2$ max.

## DISCUSSION

Conventional statistical approaches demonstrated that there were no significant differences between CV, V-MLSS, and V-LTP and that the three variables were highly inter-correlated. This suggests that CV, V-MLSS, and V-LTP might be used interchangeably to demarcate the boundary between the heavy and very heavy exercise intensity domains.

However, while this might be true on a conceptual level when mean values are considered, the bias ± 95 % limits of agreement (Bland and Altman, 1986) indicated that estimating one variable from another in individual subjects might result in significant error.

For example, if the MLSSV were to be estimated from the V-LTP in a single subject, the 95 % limits of agreement suggest that the V-MLSS might be as much as 2.1 km.h$^{-1}$ above V-LTP or as much as 1.5 km.h$^{-1}$ below V-LTP. The potential for error is obviously too great and such estimates would be unwise if precision were needed in experimental studies.

## CONCLUSION

Theoretically the CV, V-MLSS and V-LTP could all be used to define the boundary between the heavy and severe exercise domains, although it should be noted that there is a tendency for CV to be slightly higher than V-MLSS and V-LTP.

The mean results for the group suggest that: 1) the CV can be used to provide a non-invasive estimate of the V-MLSS, and 2) the V-LTP can be used to provide an estimate of V-MLSS from the results of a single incremental treadmill test.

However, it should be cautioned that, for individual subjects, there may be significant error if one parameter is estimated from another. Thus, direct determination of V-MLSS is necessary if precision is required in experimental studies.

## REFERENCES

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