

Relation between Critical Power and Functional Threshold Power

Karsten.¹✉

Introduction

Critical power (CP) provides a valid and reliable testing method (1) to monitor changes in endurance fitness (2). CP is defined as an exercise intensity that can be maintained for prolonged periods of time, typically for 45 to 60 min (3). Whilst having attracted a high level of research interest, to-date even though available as a field test (4–6), it is not widely adopted by coaches. Functional Threshold Power (FTP) on the other hand, whilst being popular in recreational cycling (7) is not well researched. FTP has been defined as the highest average power output (PO) that can be maintained for 60 min (8). CP testing requires multiple exhaustive trials which might explain the apparent gap between research and real-world cycling whilst FTP can be determined from a single maximal 20 min effort. However, FTP to-date has not been validated. Given the potential similarity, the present study investigated the relationship between CP and FTP. We hypothesized non-significant differences between CP and FTP values and a high level of agreement.

Methods

After a maximal exhaustive aerobic test, a group of physically active individuals and trained cyclists (N=12; MAP 352 ± 49 W) in randomized order performed one FTP test over 20 minutes (FTP20) and one CP test, comprising of maximal time trial efforts (TT) of 12 min, 7 min and 3 min, interspersed by 30 min rest (9). Tests were performed on a Cyclus2 ergometer (RBM Elektronik GmbH, Leipzig, Germany). During TTs and FTP test, participants utilised a self-pacing strategy where gearing was adjusted throughout efforts using the virtual gear changer mounted to the handlebars. CP was determined using the power-inverse time model ($P = W_{crit}(1/t) + CP$) and FTP60 was calculated as 95% of the FTP20 mean PO. Differences of statistical significance between CP and FTP values were tested using a paired samples t-tests. Relationships were assessed using Pearson product moment correlation coefficients. The agreement between CP and FTP60 values was assessed using Limits of Agreement (LoA). Linear regression was used to calculate the standard error of estimate (SEE) associated with predicting FTP60 values as well as for individual CP values.

Results

The mean difference between CP and FTP60 values was 5 ± 11 W, which was non-significant ($t(11) = 1.7$, $p = .108$). LoA between values were -38 – 29 W (Fig 1A). The standard error associated with the prediction of FTP60 was 18 W (CI, 13 - 28W), when expressed as percentage error resulted in 7.9% (CI, 5.8 – 12.9%). The correlation between CP and FTP60 values was $r = 0.93$, $P \leq 0.001$ (Fig 1B). The mean SEE for CP values was 4 ± 2 W.

Discussion and Conclusions

Results demonstrate low LoA between CP and FTP60 values and a high prediction error when using a group of mixed trained athletes. This suggests that CP and FTP60 results cannot be used interchangeably. By using more than one data point, an advantage of CP over FTP60 is a reduction in random error (expressed as SEE). This can be useful for coaches as it minimizes the biological re-test variability caused by the athlete. CP testing also allows the determination of W' , i.e. the maximum amount of work that can be expended above the intensity of CP. It therefore offers more information about the performance capabilities of an athlete. With some agreement present for the trained cyclists, future studies should focus on this population.



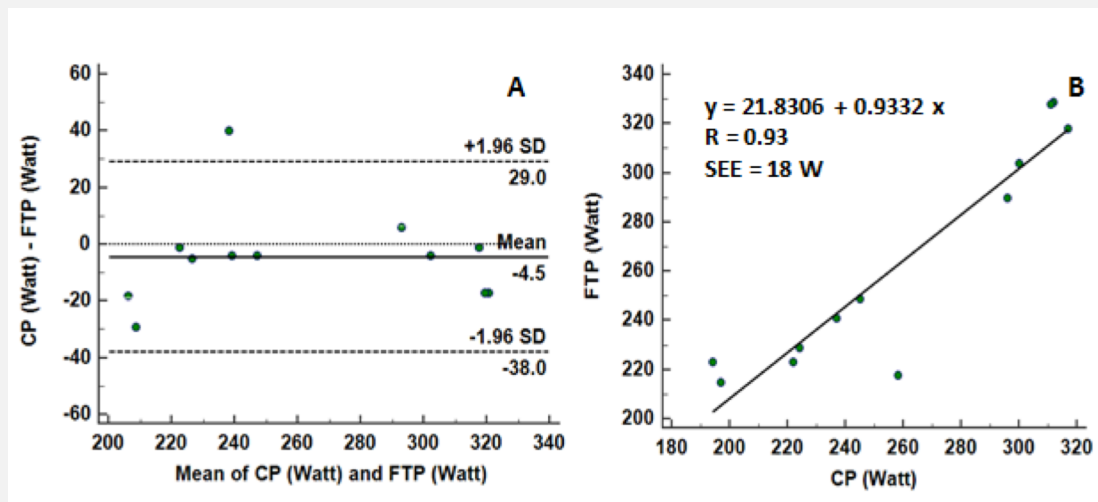


Fig 1. Illustration of the relation and bias \pm 95% limits of agreement (dashed lines) between CP

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✉ Contact email: (Karsten)

¹ Dept. of Physiology, Australian Institute of Sport