

# Functional threshold power in cyclists: validity of the concept and physiological responses

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## Introduction

Functional threshold power (FTP<sub>60</sub>) is the highest power that a cyclist can maintain in a quasi-steady state for approximately one hour without fatiguing (Allen; Coggan, 2010). In an attempt to reduce the effort time for FTP determination, the authors proposed a shorter 20-min time-trial. In this case, FTP corresponds to 95% of the power output averaged (FTP<sub>20</sub>) (Allen; Coggan, 2010). Anecdotally, FTP<sub>20</sub> is widely used to estimate FTP<sub>60</sub> and consequently used to determine aerobic training zones. In a recent study, FTP<sub>20</sub> correlated fairly with mountain bike cross-country performance (Miller et al., 2014). However, no study has investigated FTP<sub>20</sub> comparison with individual anaerobic threshold (IAT), FTP<sub>60</sub> and its physiological significance.

Purpose: To determine the agreement between FTP<sub>20</sub> with IAT and FTP<sub>60</sub> and physiological responses at FTP<sub>20</sub>.

## Methods

Twenty-three trained male cyclists were recruited (age: 33 ± 6 years; body mass: 76.4 ± 8.3 kg; height: 179 ± 5 cm; PPO: 327 ± 34 W). Cyclists performed an incremental exercise test to exhaustion, two randomised time-trials (20-min and 60-min), and a time to exhaustion (TTE) at FTP<sub>20</sub> (indoor tests). During the tests, power output, HR, VO<sub>2</sub>, [la] and RPE were measured. During time-trials and TTE, participants were able to view their progress over the course on a computer screen and were provided with information on completed distance and gear selected only. One-way ANOVA with repeated measures were used for mean comparisons between tests. The bias and limits of agreement (LoA) between performance measures and IAT were defined using the method of Bland and Altman. The confidence intervals (CI) were fixed at 95%. Statistical significance was accepted at P < 0.05.

## Results

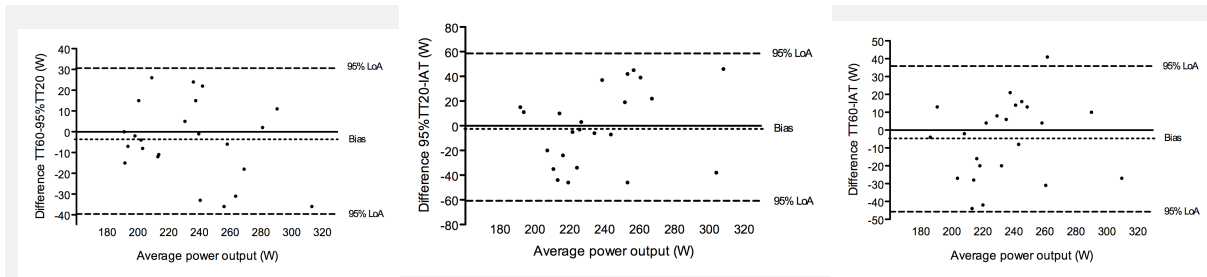
The main findings of this study are presented in Table 1 and Figure 1. The mean power output, HR and VO<sub>2</sub> of the FTP<sub>20</sub> was not significantly different than FTP<sub>60</sub> and IAT.

**Table 1.** Measures from the time-trials (TT) and time to exhaustion (TTE) expressed as mean ± SD.

Variables	IAT	FTP <sub>20</sub>	FTP <sub>60</sub>	TTE
Time (min)	-	-	-	50.9 ± 15.7
Power output (W)	237 ± 29	236 ± 38	231 ± 33	-
VO <sub>2</sub> (L.min <sup>-1</sup> )	3.6 ± 0.6	3.5 ± 0.6	3.5 ± 0.5	3.7 ± 0.7
Heart rate (bpm)	161 ± 7	159 ± 9	164 ± 11	165 ± 9
Lactate (mmol.L <sup>-1</sup> )	2.7 ± 0.5 <sup>a</sup>	-	4.2 ± 1.9	5.1 ± 2.2
RPE (Borg 6-20)	12.5 ± 1.7 <sup>a</sup>	-	15.2 ± 1.3	15.0 ± 1.2

<sup>a</sup>Significantly different from FTP<sub>60</sub> and TTE (P<0.05).





**Figure 1.** Bland-Altman plots show the bias and 95% limits of agreement (LoA) between FTP<sub>20</sub> and FTP<sub>60</sub> (-2.2 W [LoA -39 to 31 W]), and between FTP<sub>20</sub> and IAT (-1.2 W [LoA -61 to 58 W]) and FTP<sub>20</sub> vs. FTP<sub>60</sub> (-3.8 W [LoA -46 to 37 W]).

## Discussion

The most direct determination of FTP<sub>60</sub> is by simply doing a one-hour time trial. Due to the impact of pacing strategy on performance during such a long time-trial, Allen & Coggan (2010) suggested that FTP<sub>20</sub> could be more reliable for FTP<sub>60</sub> determination. Accordingly, this study showed no significant differences between 95% FTP<sub>20</sub> ( $236 \pm 38$  W), IAT ( $237 \pm 29$  W;  $P > 0.05$ ) and FTP<sub>60</sub> ( $231 \pm 33$  W;  $P > 0.05$ ). Moreover, we found low bias between FTP<sub>20</sub> and both IAT and FTP<sub>60</sub> (Figure 2). The TTE at FTP<sub>20</sub> was ~51 min, although we found a high inter-individual variability. Collectively, the results of this study support that FTP<sub>20</sub> might be used as a method of FTP<sub>60</sub> determination in trained cyclists.

## Conclusions

The FTP<sub>60</sub> is similar and showed good agreement with the power output of IAT and FTP<sub>20</sub>, although some random error might be found. In addition, TTE at FTP<sub>20</sub> was close to one hour. Therefore, this study support the concept of using FTP<sub>20</sub> to estimate IAT and the power output sustained by a cyclist for approximately one hour. However, due to high LoA caution needs to be addressed if the FTP<sub>20</sub> is used interchangeably with IAT and FTP<sub>60</sub>.

## References

- Allen, H; Coggan, A. (2010). Training and racing with a power meter. Boulder, CO: VeloPress.  
 Miller, MC; Moir GL; Stannard S. (2014). Validity of using functional threshold power and intermittent power to predict cross-country mountain bike race outcome. *J Sci Cycling*. Vol. 3(1), 16-20.

**Key words: cycling, biomechanics, power output, pedalling effectiveness, performance**

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