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Brief Report:

Reliability of power settings of the Wahoo KICKR Power Trainer after 60 hours of use

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Abstract

Purpose: The purpose of this study was to assess the reliability of power output measurements of a Wahoo KICKR Power Trainer (KICKR) on two separate occasions, separated by fourteen months of regular use (~1 h per week). **Methods:** Using the KICKR to set power outputs, powers of 100-600W in increments of 50W were assessed at cadences of 80, 90 and 100rev.min⁻¹ which were controlled and validated by a dynamic calibration rig (CALRIG). **Results:** A small ratio bias of 1.002 (95%rLoA: 0.992-1.011) was observed over 100-600W at 80-100rev.min⁻¹ between Trial 1 and Trial 2. Similar ratio biases with acceptable limits of agreement were observed at 80rev.min⁻¹ (1.003 (95% 0.987-1.018)), 90rev.min⁻¹ (1.000 (95%rLoA: 0.996-1.005)) and 100rev.min⁻¹ (1.002 (95%rLoA: 0.997-1.007)). Intraclass correlation coefficients (ICC) with 95% confidence intervals (CI) for mean power (W) between trials was 1.00 (95%CI: 1.00-1.00) with a typical error (TE) of 3.1W and 1.6% observed between Trial 1 and Trial 2. **Conclusion:** When assessed at two separate time points fourteen months apart, the KICKR has acceptable reliability for combined power outputs of 100-600W at 80-100rev.min⁻¹, reporting overall small ratio biases with acceptable limits of agreement and low TE. Coaches and sports scientists should feel confident in the measured power output by the KICKR over an extended period of time when performing laboratory training and performance assessments.

Keywords: reproducibility, power, ergometry, training

Introduction

Advancements in the technology of cycling ergometers have been shown to provide increasing accuracy in the measurement of power output. The measurement of power is an important determinant of performance and is vital for evaluating individual differences in performances, monitoring the effectiveness of both training/ergogenic aids, whilst providing a true representation of the performance capabilities of both recreational and elite cyclists.¹ Cycling ergometers which enable the use of cyclists' own bicycles have been shown to produce reliable results predictive of competitive performance whilst replicating movement economy and enhancing ecological validity, key markers of performance in the transfer of power from a laboratory setting to the field.² Therefore, the ability of a cycling ergometer to consistently record reliable measures of power output with a high degree of precision is of significant importance.

It is important for coaches and sports scientists to ensure the power measuring device they are using as part of research/athlete support is reliable.³ In order to track meaningful changes in competitive performance from an ergogenic or training intervention in elite athletes, ergometer error/bias for power output should be less than 2%.⁴ However, the majority of validity and reliability assessments on cycling ergometers have been assessed over *single* occasions,^{5,6} with evidence suggesting older ergometers may show greater biases when reliability is investigated over an extended period of time.^{7,8} With changes in performance as small as 1% often determining the difference between an overall finish on the podium or a finish within the peloton, the ability to accurately and continuously track and monitor changes in performance on the same piece of equipment over an extended period of time is therefore required.

The Wahoo KICKR Power Trainer (KICKR: Wahoo Fitness, Atlanta, GA) allows for the attachment of cyclists' own bicycles and has previously been shown to provide valid

measures of power output,⁹ falling within the manufacturers claims of accuracy ($\pm 3\%$). However, whether the Wahoo KICKR Power Trainer continues to provide continuous reliability over an extended period of time after regular use (i.e., research, performance assessments and training) has yet to be investigated. Therefore, the purpose of this study was to assess the reliability of power output measurements of the Wahoo KICKR Power Trainer on two separate occasions, separated by fourteen months of regular use.

Methods

The reliability of the KICKR power output was assessed on two separate occasions, fourteen months apart after ~120 experimental time trials (~60 h duration), by comparison with the power output of a dynamic calibration rig (CALRIG: Flinders University, Dynamic Calibrator 34118, Adelaide, Australia) as previously described.^{5,9} As per manufacturer requirements to overcome potential frictional losses, the CALRIG and the KICKR were operated for 30 minutes at 100 to 120 rev.min⁻¹ and 15 minutes at 80-100 rev.min⁻¹, respectively, immediately before the assessment of power over varying cadences. Both assessments of power were conducted in standard laboratory conditions ($18.5 \pm 3.5^{\circ}\text{C}$ and $41.5 \pm 3.5\%$ relative humidity).

A bicycle was attached to the KICKR via the SRAM/Shimano cassette. Power outputs of 100-600W were achieved by manually varying the resistance settings within ‘ergometer-mode’ within the Wahoo Fitness Application for the KICKR (Wahoo Fitness, 2014 (version 5.1.1)). Power was increased by 50W every 3 mins at fixed cadences of 80, 90 and 100rev.min⁻¹. Power measured by the CALRIG was sampled at 200Hz and recorded every second (1Hz), with data produced in the final minute of each stage used for analysis purposes, according to the methodology of Hopker et al.⁶ A standardised twenty-minute cool down was provided between each assessment cadence.

Statistical Analysis

Sustained reliability of power from the KICKR was determined using bias and 95% limits of agreement (LoA) in accordance with the methods of Bland and Altman.¹⁰ The absolute error (difference in watts) was calculated by subtracting the CALRIG Trial 2 power from CALRIG Trial 1 power. The relative error (%) in measurement of power was calculated by subtracting the power measured by the CALRIG in Trial 2 from the power measured by the CALRIG in Trial 1, divided by the average measured power of Trial 1 and Trial 2. In addition the ratio bias and 95% ratio LoA (rLoA) were calculated from log-transformed data (Trial 1 divided by Trial 2 versus the average) (GraphPad Prism 5, version 5.03, La Jolla, CA, USA). In accordance with previous research,⁵ relative measurement bias of <1.5%, 1.5-2.5% and >2.5% were deemed as highly reliable, moderately reliable and inaccurate, respectively. Using an Excel spreadsheet for reliability,¹¹ intraclass correlation coefficient (ICC) in combination with 95% confidence intervals (CI), was used to determine the degree of association between the recorded CALRIG power at Trial 1 and Trial 2. Absolute (W) and relative (%) typical errors (TE) were calculated by dividing the standard deviation of the difference between Trial 1 and 2 by the square root of 2.

Results

Overall ratio bias and 95% rLoA between Trial 1 and Trial 2 over 100-600W and 80-100rev.min⁻¹ as determined by Bland-Altman analysis are presented in Table 1. Similar bias ratios and 95%rLoA was observed for 80 (1.003 (95%rLoA: 0.987-1.018)), 90 (1.000 (95%rLoA: 0.996-1.005) and 100rev.min⁻¹ (1.002 (95%rLoA: 0.997-1.007)), respectively when observed over 100-600W.

Average relative error (%) and absolute (W) biases in measures of power from the CALRIG between trials over 100-600W and 80-100rev.min⁻¹ are presented in Figure 1 and

Figure 2. Increased errors were observed at the lower ranges of power (100-150W) regardless of cadence (80-100rev.min⁻¹) (Figure 1 and Figure 2).

An ICC with 95% CI of 1.00 (95%CI: 1.00-1.00) was observed for mean power reported by the CALRIG between Trials 1 and 2, using the KICKR over 100-600W and 80-100rev.min⁻¹. The Bland-Altman plot (**Figure 2**) clearly illustrates the average absolute differences in recorded power across the same range and cadence. There was a between trial typical error of 3.1W and 1.6%.

Discussion

The purpose of the current study was to examine the reliability of power measurements provided by the Wahoo KICKR Power Trainer on two separate occasions, fourteen months apart. The main findings from the study suggests the KICKR to have high test-retest reliability, falling within the recommended range for ergometer error, with low typical errors reported for measures of power output over an extended period of regular use.

The accuracy of an ergometer to record reliable measures of power over an extended period of time is of importance, with relatively low ergometer errors of <2% a key consideration for determination of sample sizes and for monitoring changes in cycling performance.⁴ Whether ergometer error remains low over extended periods of time is rarely investigated, with only one previous study having reported this.⁷ On two separate occasions 11 months apart, Gardner et al.⁷ reported similar reproducibility (~2.5% error) between the SRM and PowerTap mobile power trainers, suggesting good long-term reliability, however, falling outside the recommended range for ergometer error.⁴ In contrast to the findings of Gardner et al.,⁷ the KICKR was shown to have high test-retest reliability when compared to the CALRIG on two separate occasions, falling within the recommended range for ergometer error, with an overall small mean bias of 0.8% and a low typical error of 1.6%. Similar to Hopker et al.⁶ and

Gardner et al.,⁷ we observed greater discrepancies within the lower ranges of power outputs (100-200W), with an overall large mean bias of 3.1% (95%LoA:-3.0-9.2%) and 4.0W (95%LoA:-2.5-10.6W), with average relative errors of 5.1, 3.0 and 1.3%, respectively, at cadences of 80-100rev.min⁻¹ (**Figure 1**). This discrepancy may have arisen from a systematic error/consistent bias in the reading of power provided by the KICKR at the lower ranges of power, regardless of cadence.⁴

Despite large biases at the lower ranges of power, a small ratio bias of 1.00 (95%rLoa: 0.99-1.00) and relative error of 0.2% (95%LoA: -1.7-2.1%) was reported for power ranging from 250-500W, falling within the manufacturers claims for accuracy ($\pm 3\%$). With mean power for competitive and well-trained male cyclists observed to consistently exceed 250W,¹² this falls within the acceptable range of ergometer error for the KICKR (250-500W and 80-100rev.min⁻¹). However, caution should be applied by coaches and sports scientists when assessing performance within the lower ranges of power output (**Figure 1** and **Figure 2**). As previously reported,⁹ accuracy of power measures of the KICKR are shown to be influenced by cadence selection.

With cycling ergometers used to track and monitor changes in performance, coaches and sports scientists should feel confident in the reliability of power and the detection of changes within performance over an extended period of time when using the KICKR. The overall relative error (%) of the KICKR was shown to fall within the range of acceptable error for ergometers ($<2\%$)⁴, whilst the small ratio bias and narrow ratio limits of agreement between Trial 1 and Trial 2, are able to detect true changes within cycling performance.

Conclusions

In conclusion, when assessed at two separate time points fourteen months apart, the results of the present study suggest that the Wahoo KICKR Power Trainer has acceptable

reliability for combined power outputs of 100-600W at 80-100rev.min⁻¹, falling within the recommended range for ergometer error. Coaches and sports scientists should feel confident in the measured power output by the KICKR over an extended period following regular use at the higher ranges of power (250-500W) when performing laboratory training, performance assessments and for talent identification purposes, however, caution should be applied when using the KICKR within the lower ranges of power.

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	CALRIG Set Cadence (rpm)			
	80	90	100	Average (%)
KICKR Set Power (Watts)	100	2.0	2.5	5.1
	150	1.7	1.9	3.0
	200	1.1	2.1	1.3
	250	0.2	2.5	0.9
	300	0.7	1.5	0.7
	350	-1.3	1.9	0.0
	400	-0.9	-0.2	-0.5
	450	-0.1	0.9	0.2
	500	-0.2	0.3	-0.2
	550	-1.3	-0.5	-0.9
	600	-0.8	-1.4	-1.0

Figure 1. Relative error (%) between dynamic calibration rig (CALRIG) measured power at Trial 1 and Trial 2 over a set power range of 100-600W using the Wahoo KICKR Power Trainer (KICKR), and cadences of 80-100rev.min⁻¹. Errors of <1.5%, 1.5-2.5% and >2.5% are colour coded as green, yellow and red.

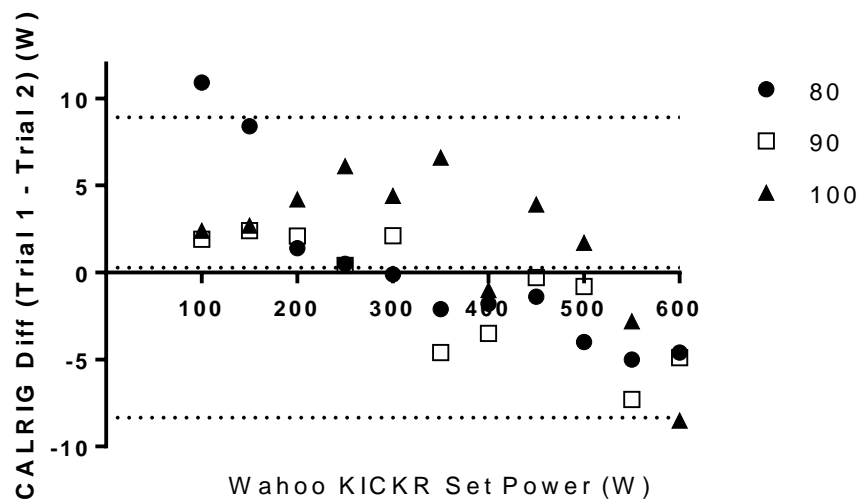


Figure 2. Bland-Altman plot of the mean difference in absolute mean power output (W) between Trial 1 and Trial 2 over 100-600W as recorded by the Wahoo KICKR Power Trainer (KICKR) and the dynamic calibration rig (CALRIG) at ●80rev.min⁻¹, □ 90rev.min⁻¹ and ▲ 100rev.min⁻¹.

Table 1. Ratio bias and 95%rLoA for differences in recordings of Power at 100-600W at 80-100rev.min⁻¹

Power (W)	Ratio bias (95%rLoa)
100-600	1.002 (0.992-1.011)
100-150	1.009 (0.993-1.024)
100-200	1.007 (0.993-1.020)
250-500	1.000 (0.997-1.004)