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The reliability and validity of the 3-minute critical power test in linear and isokinetic mode

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Abstract

Background: Exercise testing for cyclists provides key information when setting training and race strategies. Shorter testing protocols are favored by coaches and recently it has been suggested that critical power (CP) and the finite work capacity, W' , can be estimated from a single 3-minute bout of 'all-out' exercise using the Lode Excalibur Sport cycle ergometer. These estimates are termed end power (EP) and work above end power (WEP) respectively (Vanhatalo et al., 2007: *Medicine & Science in Sports & Exercise*, 39(3), 548–55). Considering the physiological basis of this test, it should be possible to accurately estimate CP and W' irrespective of the ergometer used. However, a recent study (Karsten et al., 2013: *International Journal of Sports Medicine*, 35(4), 304–9) has suggested that although reliable, the 3-minute test in isokinetic mode using an SRM ergometer does not provide a valid measure of CP or W' .

Purpose: To investigate the reliability and validity of the 3-minute critical power test in both isokinetic and linear modes using the Lode Excalibur Sport cycle ergometer.

Methods: Twelve male cyclists participated in this study (mean \pm SD; age 32 ± 6.60 yr, body mass 81.63 ± 8.57 kg, maximum aerobic power (MAP) 349.36 ± 36.14 W, $\dot{V}O_{2\max}$ 4.70 ± 0.59 L·min⁻¹). Each participant completed 8 trials, with the first carried out to calculate GET (gas exchange threshold), MAP and $\dot{V}O_{2\max}$. During trials 2–4, each participant completed three efforts to exhaustion (80, 100 and 105% MAP) in order to calculate CP and W' using both the 1/time (CP1 and $W'1$) and work-time (CP2 and $W'2$) equations. Four additional trials were carried out to estimate CP and W' (EP and WEP) from two different 3-minute protocols (linear and isokinetic modes). A repeated measures ANOVA was used to compare CP with EP and W' with WEP. Significance was set at $p < 0.05$. Coefficient of variation was used to compare EP-isokinetic, EP-linear, WEP-isokinetic and WEP-linear between each testing session. The limits of agreement between CP and EP, and W' and WEP were estimated using Bland and Altman plots for each protocol.

Results: A repeated measures ANOVA showed no significant difference between EP-isokinetic and CP1 (+3.4 W, $p = 0.38$) or between EP-isokinetic and CP2 (+0.8 W, $p = 0.965$). Significant differences were seen between EP-linear and CP1 (+30.9 W, $p = 0.004$), EP-linear and CP2 (+35.1 W, $p = 0.003$), WEP-isokinetic and $W'1$ (+8.2 kJ, $p < 0.000$), WEP-isokinetic and $W'2$ (+10.0 kJ, $p < 0.000$), WEP-linear and $W'1$ (+10.4 kJ, $p < 0.000$) and between WEP-linear and $W'2$ (+12.2 kJ, $p < 0.000$). Coefficient of variation in EP-isokinetic, EP-linear, WEP-isokinetic and WEP-linear was 1.93%, 2.05%, 8.44% and 5.39%, respectively, between trials 1 and 2. For reliability in sports science testing it has been suggested that a CV of less than 5% should be seen (Hopkins, 2000: *A new view on statistics*. Retrieved 31 March 2014, from <http://www.sportsci.org/resource/stats>). The limits of agreement between CP and EP, and between W' and WEP for each protocol can be seen in Figures 1 and 2 respectively.

Conclusions: This study suggests that the 3-minute isokinetic test provides a reliable measure of EP and a valid measure of CP. Although the 3-minute linear test seems to provide a reliable measure of EP, these results suggest that it does not provide a valid estimate of CP. Results also suggest that neither the isokinetic or linear mode provide a reliable measure of WEP or a valid measure of W' . Therefore, this study suggests that the 3-minute isokinetic test can be used to estimate critical power.

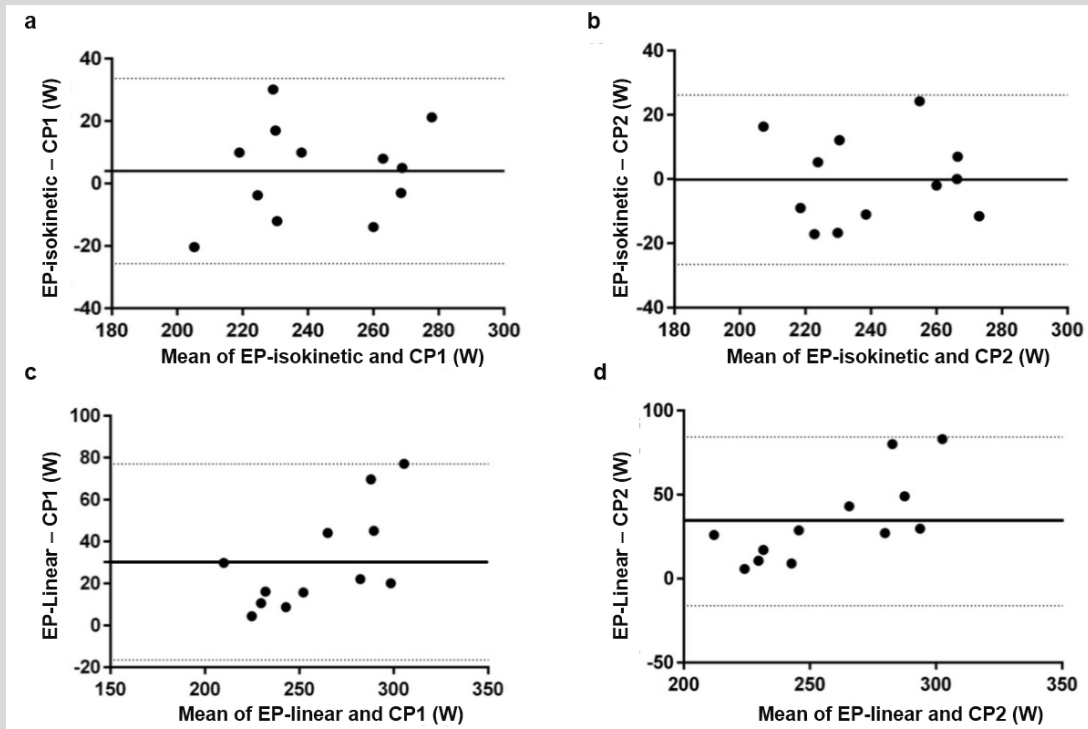


Figure 1. Limits of agreement between EP-isokinetic and CP1 (a), EP-isokinetic and CP2 (b), EP-linear and CP1 (c) and EP-linear and CP2 (d). Solid line represents mean bias. Dashed lines represent the 95% LoA.

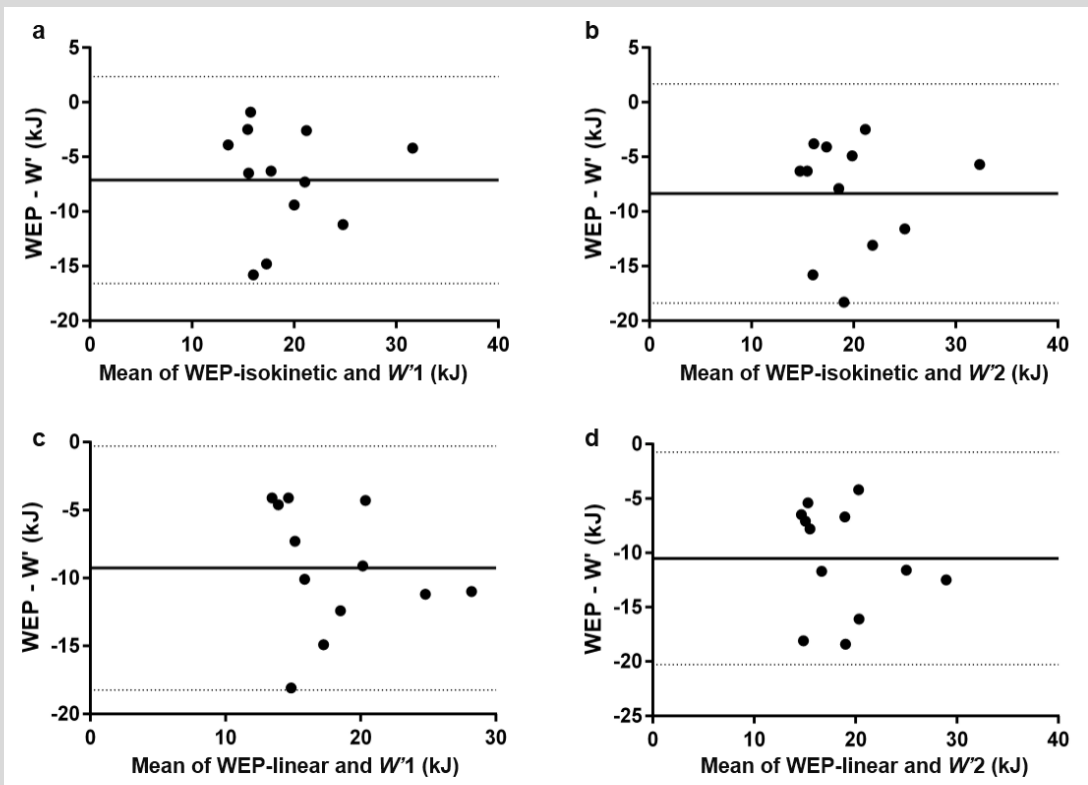


Figure 2. Limits of agreement between WEP-isokinetic and W'1 (a), WEP-isokinetic and W'2 (b), WEP-linear and W'1 (c) and WEP-linear and W'2 (d). Solid line represents the mean bias. Dashed lines represent the 95% LoA.

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