Relationship Between Isometric Peak Force and Maximal Sprinting in Elite Track Cyclists

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Introduction

Isometric strength tests have been shown to provide valuable information on force-time characteristics in various sporting movements, including running, cycling and jumping (Kordi et al., 2017, 2020; Lum et al., 2020). There is a growing interest in monitoring off-bike isometric strength levels and examining their relationship with bike-specific metrics. In particular, it has been found that isometric strength measured on an adapted cycling ergometer is a predictor of maximal torque and peak power (Kordi et al., 2017, 2020). However, what is less known is the relationship between angle-specific isometric force-time characteristics measured using a strain gauge instrument fixed on a leg press and sprint cycling (6 sec maximal sprint) performance. The purpose of this research was to investigate the relationship between angle specific isometric strength and cycling specific metrics peak power and torque. We hypothesized that there would be a positive relationship with the ability to produce force in an isometric position and the ability to produce torque and power on a cycling ergometer.

We propose that this setup would enable practitioners to track strength levels without requiring cycling-specific equipment and implement joint angle-specific isometric training in the weight room. Such information could help improve the effectiveness of strength training programs for cyclists.

Participants

Eleven elite (McKay et al. 2021) track cyclists (n=11; 3 females, 8 males), composed of six track sprint and five track endurance athletes (mean ± SD: age: 24.1 ± 3.5 yrs, body mass 82.3 ± 12.6 kg).

Methodology

The athletes completed two sessions: 1 sprint session on a SRM cycle ergometer and 1 isometric strength session. Both sessions were completed on the same day.

Ergometer Sprint Testing

Maximal sprint testing was conducted on an SRM cycle ergometer (Julich, Germany) equipped with a dynamically calibrated scientific version SRM power meter (Gardener et al., 2004). The warm-up preceding the maximal sprint test consisted of athletes performing 15 minutes of self-directed cycling, making sure athletes did one near maximal sprint within the warm-up. Immediately after the athletes performed their warm-up, athletes were instructed to complete two maximal 6-second sprints from a full stop position while seated on the SRM cycle ergometer. Each cyclist was fitted with equipment of similar geometry (e.g., seat height, seat setback, bar height, crank length) to their track bicycles used in training and racing. Data were recorded at 5 Hz, generating values representing one-revolution average (MacIntosh et al. 2004). The relationship between torque and cadence was established through a linear regression, as previously outlined (Gardner et al., 2007).

Isometric Leg Press Set Up

Isometric testing via a Mark-10 strain gauge attached to the leg press with a chain was performed 15 mins post sprint testing. Cyclists sat on the leg press with their foot placed firmly on the plate and the knee angle set to approximately 90° using a manual goniometer. A seatbelt was used to secure their hips, and each athlete completed a 50% maximal effort before starting the trial efforts. Starting with the right leg, athletes built up to a maximal effort for 4-5 seconds to avoid any countermovement. Athletes took a 60-second break between within-leg efforts and a 2-minute passive rest before the process was repeated on the left leg. Peak force (N) was recorded for each trial, and the average between the effort of both legs was used for analysis. It should be noted that all athletes had at least 1 prior session completing strength testing on the isometric leg press with the current set-up.

Statistical Analysis

The isometric leg press reliability was tested using the guidelines recommended by Weir (2005). A 2-way repeated-measures ANOVA was conducted to measure between trial reliability and separate the variance caused by systematic error versus random error, and no systemic error was observed between the isometric leg press trials ($p < .05$). The intraclass correlation coefficient was calculated using the 3,1 model (Shrout & Fleiss, 1979) and found to be 0.99 (95% CI: 0.916, 0.999), indicating good reliability. Pearson correlations were conducted to evaluate the relationships between peak forces in isometric tests, peak power data, and peak torque data.

Results

Peak force (399.32 ± 144.18 N) from cyclists' isometric strength tests were significantly correlated with peak power (1482.55 ± 368.30 watts; $r = .76$, $p = .007$) and torque (236.00 ± 53.82 N·m; $r = 0.79$, $p < .004$) for seated sprint efforts (see Figure 1).

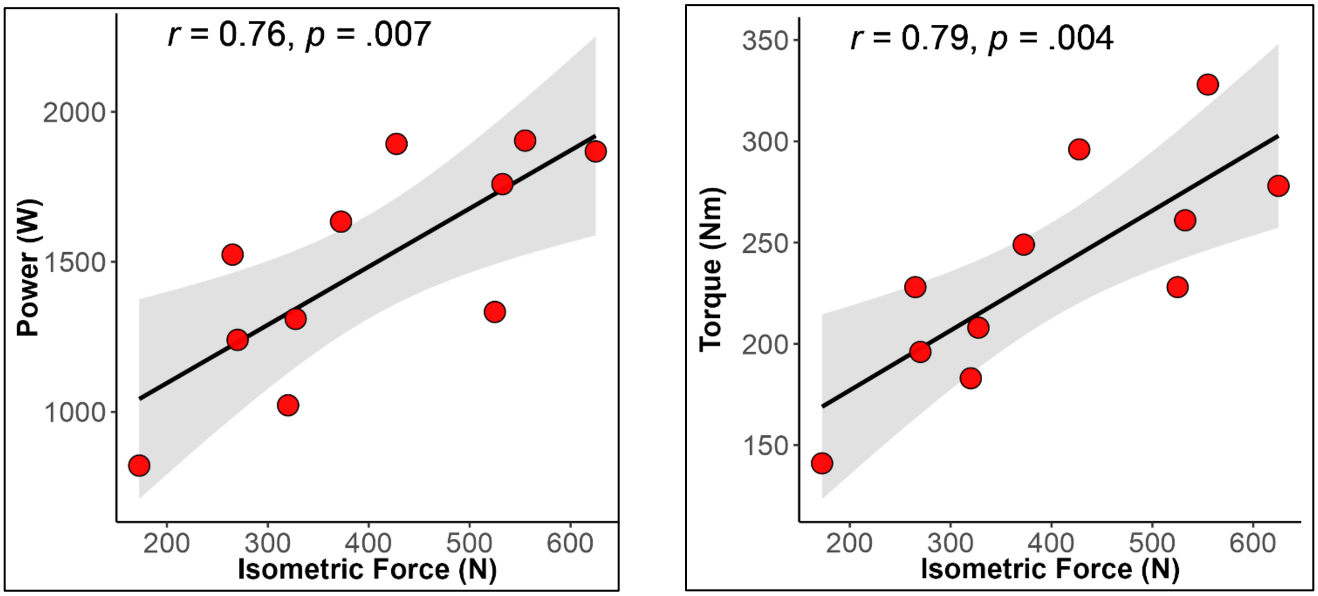

Figure 1. Scatterplots depicting correlations between isometric force and peak power (left panel) as well as isometric force and torque (right panel). The shaded grey areas represent 95% confidence intervals.

Discussion

The significant correlations suggest that peak force in a single-leg isometric press can predict torque and peak power characteristics during a maximal sprint on an SRM cycling ergometer. This provides strength coaches with an alternative way to monitor athletes and provides insight into their strength levels as it relates to cycling performance without using custom-built cycling ergometers (Kordi et al., 2020).

Practical Application

The results of this study provide some initial data to suggest a feasible solution to practitioners that is easy-to-administer, task-specific and a safe testing tool to track and monitor a sprint cyclists' torque, force, and power characteristics, especially when access to a power meter or laboratory-grade cycling ergometer is not accessible. In light of the results of this study, cycling practitioners may use this information to devise isometric training protocols within a weight room. Future work is warranted with a larger cycling population to confirm these results and to investigate the longitudinal utility of peak isometric force to assess changes in peak torque and peak power in elite track cyclists.

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