Influence of power output on pedalling biomechanical parameters in cyclists of different competitive levels

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Introduction

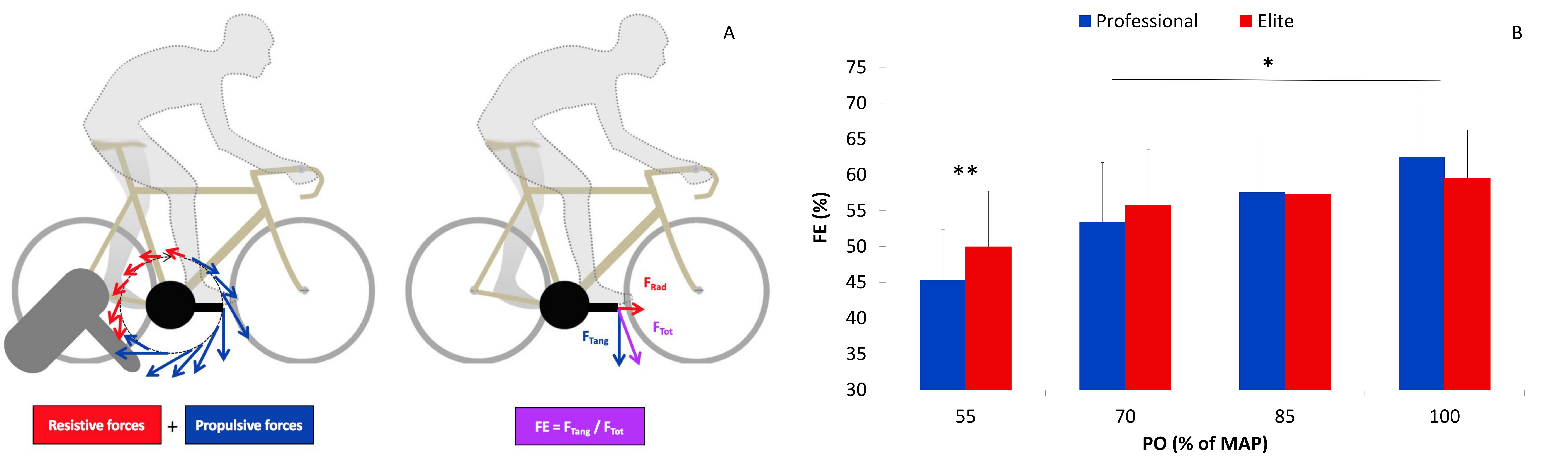
Cycling performance depends on several physiological and biomechanical parameters. The influence of biomechanical factors such as pedalling technique is still an issue of debate. Several studies demonstrated that pedal force effectiveness (FE, %, ratio of the force perpendicular to the crank and the total force applied to the pedal) has also been used as a gold standard measure of pedalling technique in cycling. However, FE depends on several constraints such as power output (PO, W), pedalling cadence, body position, fatigue, and cycling experience. Studies showed that large increase in PO (i.e. from 60% to 98% of the maximal aerobic power [MAP]) led to higher FE. Additionally, a recent study showed that professional cyclists have better pedalling technique than elite or club cyclists [1]. The purpose of this study was to assess the influence of PO on pedalling technique in cyclists of different competitive levels using FE as a performance clue.

Methods

37 male road cyclists of different competitive levels (elite [19] and professional [18]) performed all testing sessions on a Bikefitting ergometer (Shimano, Pedal Analyzer, Dynamics Lab, Sittard, Netherland) that has been used to assess FE in seated position. Firstly, the personal bike position of each cyclist was reported on the ergometer. Then, the cyclists were required to perform exercises at four level of PO (55, 70, 85 and 100% of MAP). The cyclists were asked to keep their preferred pedalling cadence during each level of PO. The main parameter measured was FE (Figure A) whereas the balance between propulsive and resistive forces (%) was also measured as a secondary parameter.

Results

The figure B shows an increase in FE with PO (+26.4% from 55 to 100% of MAP, $p < 0.001$). Even if the competitive level did not influence FE, the increase of FE according to PO was higher (+36.1%) in professional cyclists than elite cyclists (+19.1%). Additionally, the coefficient of variation (CV, %) decreased with PO ($CV_{55\%}$ = 16.2 %, $CV_{70\%}$ = 15.0 %, $CV_{85\%}$ = 12.8 % and $CV_{100\%}$ = 11.0%). For all PO and competitive levels, FE was correlated with both PO ($r = 0.47$, $p < 0.001$) and the balance between propulsive and resistive forces ($r = 0.82$, $p < 0.001$). Finally, the resistive forces were significantly ($p < 0.001$) decreased from 15.8 to 5% between 55 and 100% of MAP during the upstroke.



Discussion

The main findings of this study show that FE was influenced by the level of PO and was independent of the competitive level. Yet, professional cyclists increased faster FE with the level of PO suggesting that their pedalling technique was further improved in high levels of PO as compared with elite cyclists. Previous studies showed that an increase in PO induced an increase in FE [3]. In this study, for a given PO, the increase in FE was due to a lower resistive force. Concerning the effect of competitive level, previous studies have shown no difference in FE between cyclists of different competitive levels [2] whereas another study [1] demonstrated that professional cyclists had better pedalling technique than elite cyclists. Finally, it appears that with the increase of PO, the professional cyclists improve their pedalling efficiency both by increasing FE and decreasing the resistive force during the upstroke of the pedalling cycle.

References

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