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Efficiency index of a pedaling monitor system depend on load power, cadence and body weight

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Abstract

Background: In recent years, a variety of power meters for bicycles has become commercially available (Allen & Coggan, 2010: Training and Racing with a Power Meter (2nd edn.). Boulder, Velopress). In particular, a pedaling monitoring system (SGY-PM900H90, SGX-CA900: Pioneer Corporation, Kawasaki, Japan) is a device that displays a pedaling force vector to decompose the tangential and normal direction of pedaling force (Pioneer Cyclesports, “Pedaling Monitor Sensor”. Retrieved 20 March, 2014, from http://pioneer-cyclesports.com/us-en/). No other such devices exist except for those used experimentally. This device can display the efficiency index of the pedaling force. Although we can see the pedaling force vector diagram and the efficiency index change every second, it is difficult to understand the state of the averaged pedaling force vectors (Bibbo et al., 2008: A wireless integrated system to evaluate efficiency indexes in real time during cycling, 4th European Conference of the IFMBE Proceedings, 22: 89–92).

Purpose: The purpose of this study was to reveal the influence of load power, cadence, and body weight on the efficiency index of the pedaling monitor system by averaging the pedaling force vector signal obtained from the pedaling monitor system over a measuring period.

Methods: Twenty-eight participants were given the pedaling load step up from ~150 W to ~300 W by a bicycle trainer (Powerbeam Pro-trainer: CycleOps, Madison, WI). The pedaling force vectors during the step load were recorded. Cadence was not specified: each participant had decided on a comfortable cadence. Using a pedaling force vector obtained from the experiment, the pedaling force vector was averaged at each load step, and the efficiency index was determined from the averaged pedaling force vector. Multiple regression analysis was conducted with the efficiency index as an objective variable, and load power, cadence, and body weight were set as explanatory variables.

Results: The efficiency index was significantly correlated (multiple correlation coefficient: r = 0.732, p-value = 4.6 x10-21) with load power (regression coefficient: □□= 0.078%, p = 3.2 x10-16), cadence (□□= -0.429%, p = 2.0 x10-10), and body weight (□□= -0.383%, p = 1.4x10-7). Using the coefficient value of the multiple regression analysis, the efficiency index was compensated to remove the effects of these factors (load power, cadence, and body weight). As a result, the average compensated efficiency index was 50.2% at 250 W, 100 rpm, 65 kg, and the standard deviation was 5.2%.

Discussion: The result was considered to be due to the influence of the load effect, which was applied to the pedal by centrifugal force and gravity of the leg weight. The variation in the compensated efficiency index was small, after removing the effects of load power, cadence, and body weight. It was considered that the features of pedaling of the participant were reflected in the compensated efficiency index. According to the actual pedaling force vector, the effect of downward force in the recovery phase was large.

Conclusion: In order to reveal the influence of load power, cadence, and body weight on the efficiency index of the pedaling force vector, multiple regression analysis was made with the efficiency index calculated from the averaged pedaling force vector. As a result, the following became clear: (1) the efficiency index can be compensated to remove the effects of these factors (load power, cadence, and body weight), and (2) it is possible to understand the features of the participant's pedaling technique from the compensated efficiency index.

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