The Effect of Different Cadence and Gear Ratio on Pedal force and Riding Stability

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Abstract

Background: How to ride more efficiently is always a question researchers and coaches are discussing. In the past, it is often discussed which cadence and gear ratio has the best efficiency. The energy output during riding is mainly generated by pedaling and exerting a force on the body to maintain riding balance. Many previous studies were conducted on the pedaling efficiency of professional cyclists cycling in different modes. Whereas, the pedal efficiency and body movement caused by the energy consumption of non-cyclists riding in different modes is still lack of empirical scientific evidence.

Purpose: To explore the impact of pedaling force, pedaling efficiency and the variety of body movement while the non-cyclists cycling under different cadences and different gear ratios.

Methods: Twelve healthy male participants (non-cyclists) were enrolled in this study. A road bike was mounted on an indoor bike trainers for the cycling test. Participants could practice using the bike before the test. The cycling test was performed with different cadences (60 rpm, 75 rpm, 90 rpm) and different gear ratios (53/28, 53/23, 53/19, 53/15, 53/12). A 3-axis load cell is installed on the road bike pedal to measure pedaling force (resultant force (RF) & effectiveness force (EF)) and pedaling efficiency. The Vicon 3D motion analysis system and the force-plate are used to analyze the center of mass (COM) variety to cyclist and cyclist-bike system. After collecting the data, repeated measured two-way ANOVA was used to determine the differences of pedaling efficiency and the variety of body swaying among different cadence and gear ratio of cycling. For post-hoc, bonferroni method was used, with the significant level set at $\alpha = .05$.

Results: After the statistical analysis of repeated measured two-way ANOVA, it is found to have no significant interaction between different cadences and gear ratios ($p > .05$). In the analysis of pedaling force, in different gear ratios, RF, EF and pedal efficiency at the heavy gear ratio (53/12) is significantly higher than the light gear ratio(53/28 or53/23) ($p < .05$). In different cadences, only RF at high cadence (90rpm) is significantly higher than low cadence (60rpm), and the other pedaling parameters are not significantly different in different cadence. In the analysis of body swaying and stability, the lateral axis COM variety of cyclist and cyclist-

bike system both increased significantly with the increase of cadence($p<.05$). There was no significant difference in cyclist COM variation between different gear ratios. However, cycling stability at different cadences and gear ratios were not significantly different.

Conclusion: For non-cyclists, it is recommended to use a higher gear ratio and lower cadence. When gear ratio increases, it effectively increases the efficiency of pedaling, and the variety of body movement will not change if the gear ratio increases. Selecting lower cadence could cause less body movement while cycling, reducing the energy consumption to maintain cycling stability. In the future, the EMG signal can also be taken into consideration. Although the gear ratio is more efficient in the results of this study, the result of the energy paid in the body is still unknown and worth further clarification in the future.

Keywords: pedal efficiency, energy consumption, riding balance