THE EFFECT OF PEDAL FORCE IN DIFFERENT RESISTANCE DURING SITTING OR STANDING CYCLING

Po-Ling Chang, Yu-Kuang Wu and Tzyy-Yuang Shiang
Graduate Institute of Exercise & Sport Science National Taiwan Normal University, Taipei, Taiwan; email: tyshiang@ntnu.edu.tw

SUMMARY
The purpose of this study is to compare the performance of pedal force applied by subjects in different resistance (low, middle and high) while cycling in sitting or standing posture. Stationary bicycle and force sensor were used in this study. Two-way ANOVA was used for statistical test. The result in different resistance shows that pedal force exists significant difference in sitting posture, but there is no significant difference in standing posture instead. This might result from the participation of body weight and different level of muscle exertion. Both body weight and muscle strength affected the pedal force in these cycling conditions.

INTRODUCTION
The research topic in the field of bicycle usually investigates two main themes: one is human performance and movement including muscle strength, riding posture, upper extremity position, joint angle etc., the other is equipment design including gear ratio, saddle form or height, length of crank arm etc. Some studies focused on uphill cycling in different riding posture [1] or investigating muscle coordination while cycling on different uphill grades [2]. However, no study focuses on pedal force applied by subjects in different posture. General speaking, the resistance of outdoor cycling is from slope. We hypothesize that in fixed RPM (revolution per minute) condition which means excluding the factor of gear ratio, the cyclist’s effort might not change too much at low slope between sitting and standing posture, but at higher slope different posture might change the effort condition obviously. The purpose of this experiment is to delve the pedal force applied by subjects in (1) different level of resistance and (2) in sitting and standing posture. The independent variables are different postures and resistances and the dependent variable is pedal force.

METHODS
Twelve healthy male subjects (age 22.5 ± 1.7 years, height 172.7 ± 4.4 cm, weight 67.5 ± 7.6 kg, length of thigh 37 ± 1.7 cm, length of shank 41.6 ± 1.8 cm) were recruited in this experiment. All subjects came from the department or graduate institute in physical education and had the habit of exercise in daily life. A stationary bicycle (flywheel, Magtonic Inc., Taiwan) with a 6-Force-Component-Tranceducer (LFX-A-3KN, Kyowa Co., Japan) mounted at the right pedal, the photoelectric sensor which defines crank angle, were used in this experiment. All signals were recorded with a Biopac MP150 system (Biopac Inc., USA). The experimental design was two-way repeated measurement design (2 different postures × 3 different resistances). In order to exclude the carryover effect in sequent treatment, we adopted Latin square method for counter balance. During experimental procedure, we only recorded right pedal force data applied by subjects’ right foot, and controlled the pedaling rate at about 50 RPM in each trial [3]. The resistance was defined by the mechanism of brake at the flywheel. Before test, all subjects received bicycle fit [4] and did standard warm-up exercise. At the beginning of each trial, all subjects started cycling from the same pedal position (left pedal at 180 degree), then maintained 50 RPM at least 30 seconds. 2 minutes break was required between each trial. Acqknowledge 3.9.1 software was used to collect data with sampling rate 1000Hz. We chose and analyzed fifteen stable pedaling cycles. Peak values of pedal force at z-axis were averaged. A two-way repeated measures ANOVA was used for comparison with an alpha level of .05.

RESULTS
Referring to Figure 1, in comparing with different postures, all sitting posture trials are significant less than standing posture trials with the same resistance ( p value all < .05). Comparing with different resistances, in the sitting posture, the pedal force in low level resistance is significant less than middle and high level resistance. Also, the pedal force in middle level resistance is less than high level resistance ( p value all < .05 ). However, there is no significant difference existing between different levels of resistance during standing posture trials ( p value = .546).

DISCUSSION
In this study, we compared different level of resistance (low, middle and high) in sitting and standing posture respectively. In sitting posture, the higher level of resistance it is, the larger
pedal force subjects applied. This might result from the more number of lower extremities muscle recruited to maintain the same RPM. However, in standing posture, subjects tend to use the body weight to achieve different level of resistance. Body weight may play an important role on standing posture trials. This is one possible reason which explains pedal force did not change when the level of resistance increased.

CONCLUSIONS
When raising the resistance in sitting posture trials, subject must use more muscle strength to maintain the RPM. However, body weight could help maintaining the RPM in standing posture trials. In the future, EMG or crank torque parameters could be used to study more detailed about this topic to ensure whether the percentage of muscle recruitment change or not.

REFERENCES