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Influence of Initial Crank Positions and Jaw Clenching Activity on Cycling Performance

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Abstract. The purpose of this study was to identify the effects of three initial crank positions and jaw clenching activities on seated cycling performance. 10 normal subjects (5 females, 5 males) completed six separate occasions of Wingate Test with three different initial crank positions (0º, 47º, 71º) and two modes of jaw activities (jaw clenching and jaw loose). The findings suggest that, crank angle of 71º has the highest power output compare to other angles. The combination of 71º crank angles and jaw loose the jaw shows the best cycling performance.

1 Introduction

Cycling is a competitive physical activity which could be categorized in racing and non racing categories. The racing categories includes road cycling, track cycling, time trialling, cyclo cross, mountain bike racing, bicycle motocross (BMX) and cycle speedway while the non racing categories comprise of artistic cycling, cycle polo, freestyle BMX and mountain bike trials.

Several factors were reported to influence the racing cycling performance including but not limited to environmental, mechanical, strategy and human factors [1]. As for human factors, body position, configuration and orientation were assessed by various researchers as to improve the cyclist performance. The influence of body configurations on cycling performance were reported to receive large attention by researchers [2][3].

The cyclist leg segment position influenced the moment generated at pedal axle and also force generated by the muscles. Padulo et. al have studied the effect of initial crank positions on cyclist speed and acceleration in track cycling performance. It was found that the acceleration with standing position and initial crank position of 71° was about 35 % greater than that with seated position with an initial crank angle of 47° [4].

Other than initial crank position, other human factors e.g. jaw clenching activities were reported to improve cycling performance as well. Clenching the jaw, grasping firmly the hands and attempting to inhale out through a closed mouth at the same time, was reported to expand knee power by 14.8% that may influence the cycling performance [5]. However, to the best of author knowledge, there is no study combines both effect of cranks initial

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position and jaw clenching activities on seated cycling performance. Therefore, in this project, we investigate the influence of three initial crank positions, level of comfort and jaw clenching and jaw loose activities on seated cycling performance.

2 Methodology

2.1 Subject

In this project, 10 (5 males and 5 females) university students (age is between 23.5±1.5 years old and height is 170.5±11.5cm tall and weighing 66.5±11.5kg.) volunteered as participants. Subjects were healthy without any muscular, neurological and tendineous injuries. All subjects was voluntarily agreed to participate in the study and signed the consent form prior to participation.

2.2 Experimental equipment

A kinetic fluid cycle trainer, Tacx Vortex Smart model T2810 was used to acquire the speed, cadence and power output during cycling. It also functions to hold the bike upright and to provide the desired resistance to the back wheel. A goniometer (Lafayette Gollehon Extendable Goniometer, model 01135) was used as a part of test for measuring the angle of knee when subject sit on the adjusted bicycle seat. This instrument was used to adjust bicycle seat height based on Holmes method, where the knee angle must be in the range between 25º to 35º during sit on saddle seat. The goniometer was also used to set the initial crank position of the cyclist. Cycling data from TACX Vortex were transmitted into a tablet through ANT+ wireless networking protocol.

2.3 Experimental procedure

The experiment began by measuring subject's height and body mass for calculating the Body Mass Index (BMI). The bicycle seat height was adjusted according to the Holmes method. Subject seated on the bicycle before start the experiment. Then, subject start cycling according to Wingate test method with combination of with or without jaw clenching activities in a separate session. The initial crank positions setting start with 0º, followed by 47º and 71º in each cycle of experiment. The mean power outputs were recorded and analyze offline using Microsoft Excel 2010.

2.4 Data analysis

All statistical analyses were performed using SPSS version 17.0, (SPSS Inc., Chicago, IL). The data of the protocols were tested for normality and homogeneity of variance and turned out to be normally distributed. Therefore, the analyses of differences in power outputs and comfort ratings between initial crank positions and jaw clenching activities were detected using 2 Way ANOVA. Results for all tests were considered significant at $p < 0.05$.

3 Result and discussion

3.1 Power output at difference crank angles

Figure 1 shows the average power output for the three initial crank positions. The bar graph showed that the 71º crank position had the highest overall ranking among the three initial crank positions. Table 1 shows the result of ANOVA test between relative power output and the different initial crank positions. For all subjects, ANOVA test revealed a non significant difference in cycling relative power output due to the different settings of initial crank positions ($p = 0.910$). Padulo. J. et. al. found that the acceleration at initial crank position of 71º was about 35% greater than that with seated position with an initial crank angle of 47º [4]. In evaluating the effect of the initial crank position on cyclist performance, perhaps, it is better to opt for acceleration or speed rather than the power output. In this study, although the cyclist show higher power output during the initial cycling stage at different initial crank position; the analysis using average power output resulted in minimal difference of power output at different initial crank position. Perhaps, it is better to measure the instantaneous rather than mean power output at specific experiment time.

Table 1. ANOVA Test Between Mean Power Output and Different Initial Crank Angular Positions

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.180	2	0.090	0.094	0.910
Within Groups	54.407	57	0.955		
Total	54.588	59			

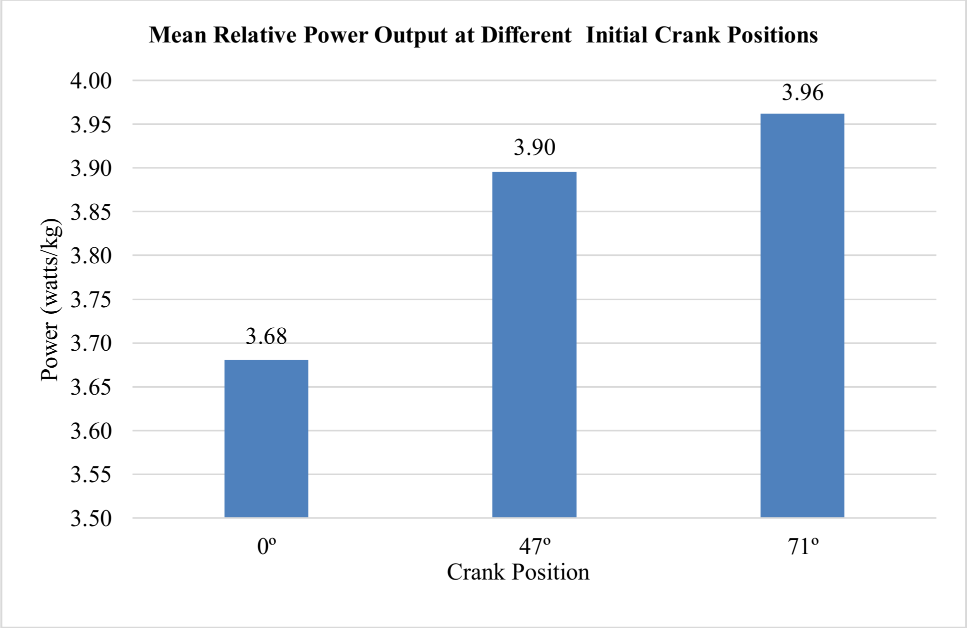

Fig. 1. The average power output between the initial crank angular positions.

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3.2 Power output for jaw clenching and jaw loose activities

Table 2 presented the result of ANOVA tests for the jaw clenching and jaw loose activities. There is statistically significant difference in the jaw clenching and jaw loose jaw activities in terms of power output. As shown in Figure 2, the jaw jaw loose mode generate more power output compared to jaw clenching. However, according to William et. al., clenching the jaw, grasping firmly with the hands and attempting to inhale out through a closed mouth, at the same time, expands knee power by 14.8% when performing leg extension using Biodex System Dynamometer [5]. In this project, confirmation of clenching and jaw loose activities were performed using hand (palpation on jaw clenching) before the subjects start pushing the pedal downstroke, and thus, none could confirm that they definitely clenched their jaw when pushing the pedal towards bottom dead centre. There is a possibility that subject clenched their jaw in the unclenched jaw mode too. In future, method of confirming the clenching activities (using electromyography signal of jaw and etc) should be introduced to obtain a better results.

Table 2. ANOVA Test for Jaw Clenching and Jaw Loose Activities.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.279	1	5.279	6.209	0.016
Within Groups	49.309	58	0.850		
Total	54.588	59			

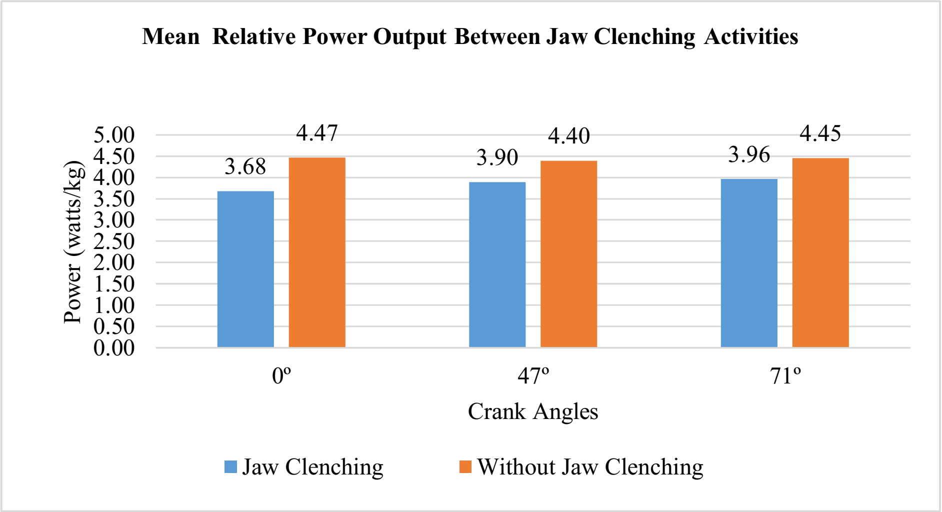

Fig. 2. Average power output between jaw clenching and jaw loose.

4 Conclusion

The main objective of this study is to assess the influence of crank's initial position on cycling performance. In this project, three types of initial crank positions, and the activities of the jaw clenching and jaw loose during cycling in seating position were utilized to understand their effects on cycling performance. There is no significant difference ($p>0.05$) in result for power output with different initial crank positions. The reason probably is due to the difference in power output value between the initial crank positions is not so large. There is a significant difference between jaw clenching and jaw loose activities during seated cycling in term of power output. The subjects generate power output higher when cycling with jaw loose jaw. In conclusion, from a performance standpoint, crank angle of 71º has the highest power output compare to other initial crank positions. Not only that, the combination of 71º crank angles and without jaw clenching could improve cycling performance.

5 Recommendation

More experiments to be carried out to have a deeper knowledge on the influence of initial crank angular position on cycling power generation. It is also advisable to utilize motion capture system to understand lower limb joint power and moment produce at different initial crank positions. Additionally, seat height, body posture and seat position (front and back) of the cyclist also should be considered to improve the cyclist performance. In addition, the difference between the genders should also be taken into account due to the difference in strength of both genders.

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