The purpose of this study was to determine the effect bicycle crank length has on delta efficiency in recumbent vehicles with 115, 140, and 170 mm tested in the wind tunnel. The crank lengths of 115mm, 140mm and 170mm were used in the study. Focus was placed on cranks that are shorter than the typical 175mm crank. Cranks shorter than 170mm tend to allow a higher cadence which is preferred by many experienced riders. Shorter cranks also allow for a more aerodynamic vehicle profile and may offer improved knee and hip movement over longer crank arms. For this study a volunteer group of 12 males and 9 females (21, mean [SD] age 27.7 ± 1.46, and cranks [110.2 ± 0.5 cm] were selected to ride on a recumbent cycling equilibrium with a typical leg angle of approximately 115°. To determine delta efficiency (DE), cycling power and metabolic power output was measured for each subject at 3 power levels for each of the three cranks being tested. The mean DE for the 115mm, 140mm, and 170mm crank was 0.3691, 0.3186, and 0.01483 respectively. It was found that there is no statistically significant difference in DE on the horizontal line (p = 0.65) for the three cranks. For this reason the length of crank used by recumbent riders should be chosen based on factors other than an effect on DE.

MATERIALS AND METHODS

INTRODUCTION

The length of crank used on recumbent vehicles as it relates to delta efficiency (DE) has not yet been addressed in the literature. To date, few have given special interest in crank lengths that are shorter than conventional cranks because they may offer distinct advantages to recumbent vehicles. Substantial anecdotal evidence provided through communications in bike forums and periodicals speaks of better cycling comfort in recumbent vehicles. Some experienced cyclists including the authors prefer shorter cranks in recumbent bicycles but they are not yet able to indicate what effect crank length has on DE. This study investigates the effect of crank length on DE in recumbent bicycles with high bottom brackets.

An advantage many cyclists enjoy over upright bicycles is the more aerodynamic profile (Hoff, Kerl, & Mihalec, 1983). Recumbent bike manufacturing firms focus on making shorter crank arms in a standard crankset for a better fitting frame, producing a vehicle that is more aerodynamic and requiring less effort to pedal. Longer crank arms increase wind resistance and decrease the aerodynamic profile. Cranks shorter than 115mm may offer increased aerodynamic savings. One benefit of shorter cranks is the smaller change in joint angle resulting from the legs’ tibio-femoral joints. Shorter cranks may also allow for a more symmetrical pedal position. Hence, the research question is: how does crank length affect DE in recumbent bicycles? This study was conducted to answer this question.

RESULTS

The primary finding of this study was that the crank length used on a recumbent bicycle with a high bottom bracket is a significant factor in the delta efficiency results of this study. McDaniels and his colleagues did a study on upright cyclists and found that DE increased by 0.014 at 90 cm (35.4°) legs relative to 120 cm (47.2°) legs. For recumbent cyclists, a significant increase in DE was not observed until the length of crank surpassed 120 cm (47.2°). This increase was attributed to the larger forces required to maintain a consistent cadence.

The variability in the data can be attributed to the subjects being tested. DE varied most between subjects rather than changes in crank length. Some subjects can be attributed to the diversity of subject age, gender and fitness level.

Subjuect variability, with regard to exchange ratio measurement may contribute to the greater variability in metabolic values of delta efficiency. Few subjects clearly exhibited anomalous values for the initial test. This was fixed and there were no such subjects for the subsequent normalised tests. The subjects were not selected to the results. In future studies, subjects should be given more familiarisation time with the ergometer.

Future studies should be conducted using cranks both shorter than 115mm and longer than 170mm to study the effect for a wider range of crank lengths. This may be helpful to conduct a study of smaller crank lengths on the effect of shorter cranks that are more alike in age, gender, and fitness level for example, a group of well trained male cyclists aged in factors that may make DE similar to one another. If there is an effect on DE due to crank length these alterations may show it.

BIBLIOGRAPHY

Dr. Archibald and Tyler Baker would like to give special thanks to the Sweeney fund for making this research possible.