# HMST4925: Research Proposal

**The effect of grip and posture on power generated by the upper and lower limbs on subsequent movement of the centre of mass during a 5-second maximal power (sprint) task.**

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**Introduction**

Previous research has proven that the upper body force produced by cyclists via the handlebar grip is effective at increasing power output at the crank (Baker et al., 2002). Specifically, Baker.et.al (2002) found that maximal power output produced over one crank cycle during seated cycling is reduced by 22% when riders are not able to grip the handlebar. Analyses of the power transferred across the hip joint to the crank have shown that power contributed by the trunk and upper limbs increases almost linearly with power output; reaching ~13% at ~1000 W (Elmer et al., 2011). Changing posture from seated to standing has also been associated with significant changes in the amplitude and timing of muscle activations (Turpin, et.al 2016). The findings of Davidson et al. (2005, Pilot study) suggest the increase in maximal power during non-seated cycling can be explained by a greater contribution of power from muscles in the upper body. Turpin et al. (2017) provided further evidence that a rider’s upper body muscles are more activated during high-power output cycling in a non-seated posture compared to when seated. Hence, it has been suggested that the contribution of force made by the upper body via the handlebar grip is to help to overcome the large resistive loads typically encountered during high-power output cycling (Baker, 2001). Turpin et al. (2016) provided a similar theory that increasing pedal forces lead to larger upward reaction forces acting on the trunk, which tend to lift the upper body. However, it should be noted that neither Baker (2001) or Turpin et al. (2016) directly measured the vertical forces acting on the rider.

Another factor needed to be considered is the rider’s centre of mass (CoM). Research by Baker (2001) and Dore et al. (2006) both theorised that by pulling up on the handlebars, a rider prevents upward acceleration of their CoM. Thus, the CoM of the body is maintained at a constant vertical level (i.e. fixed to the seat), which allows leg extension power to generate greater levels of crank power (Dore et al., 2006). Wilkinson et al. (2020) found that the vertical motion of the rider’s CoM can act as mechanical amplifier during non-seated cycling. It appears that for a given power output, changes in CoM energy contribute to peak instantaneous power output at the crank; possibly reducing the required muscular contribution (Wilkinson et al., 2020). Greater upper body joint power contributions occurred at higher power outputs and when cadence was reduced, helping to explain why maximal power outputs are higher when riders are able to grip the handlebar (Wilkinson et al., 2020).

The aim of this study is to examine the effects of grip versus no grip in both a seated and non-seated posture on power generated by the upper and lower limb and subsequent movement of the CoM during a 5-second maximal power (sprint) task in recreational cyclists. We suspect that more power will be generated by the upper and lower body during grip conditions compared to non-grip in both postures. We also suspect the effect of grip will be larger in the non-seated posture and that CoM displacement will be reduced in the grip conditions compared to the no-grip conditions.

**Research approach**

This study uses a repeated measure, within-subject design involving 3 x 5-s maximal sprint efforts at a cadence of 120 rpm, under four conditions. These conditions are: seated grip, seated non-grip, non-seated grip, and non-seated non-grip. We aim to recruit 8-12 recreational cyclists to complete this study. All participants are required to give their written informed consent prior to participating in the study in according to the procedures approved by the Human Movement Ethics Community of the University of Queensland via the submission of a National Health and Medical Research Council (NHMRC) Human Research Ethics Application (HREA).

Adequate warm-up and rest periods will be given between each trial and condition. Lower-body power will be measured by recording the tangential and radial forces at the left and right crank, as well as crank angle at 100 Hz using pre-calibrated, wireless, instrumented cranks (Axis, SWIFT Performance, Brisbane, Australia). This study will use calculations from Wilkinson et al. (2020) to estimate upper-body power and CoM movements by combining a kinematic and kinetic approach to CoM movement and joint powers. Equations 1 and 2 below show how the net force acting at the handlebar (Fhb) will be calculated by comparing the total vertical force (Fz) required to cause the measured accelerations of the rider’s CoM (acom) with the sum of vertical force at the left (Fcl) and right (Fcr) cranks.

1:

2:

Using data recorded from three-dimensional motion capture, we will use inverse dynamic analysis to calculate hip, knee, and ankle net joint moments by combining the inverse kinematics results with crank forces (Wilkinson et al., 2020). This entails scaling limb lengths and segment masses of a previously developed generic full-body musculoskeletal model based on each participants anthropometry. The total joint power generated by the rider (Ptot) at each instant during the crank cycle will be equivalent to power measured at the cranks (Pcranks) plus energy lost or gained by the rider’s CoM as shown in Equation 3 (Wilkinson et al., 2020).

3:

**Analysis**

A repeated measure, two-way analysis of variance (ANOVA) will be performed to test for main and interaction effects of grip and posture on upper and lower limb power, crank power, and the range of CoM vertical displacement. The pattern of joint power and CoM movement over a crank cycle will also be presented.

**Research Study Timeline**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Week** | **-2** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| **Tasks** |
| Meeting with supervisors | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h | 1h |
| Reviewing literature |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ethical Approval |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Aim/Hypothesis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Recruitment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Intro & Methods Review |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Pilot testing |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Testing |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Draft Report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Discussion/Conclusion |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

The research timeline above outlines the tasks required to complete the project. The ethics of this study have already been approved. Participant information and consent forms have also been completed. Booking subjects for testing sessions relies on availability of necessary laboratory equipment such as the ergometer, 3D motion capture, and instrumented cranks. Testing sessions will be 90 minutes long followed by a decontamination period. We aim to complete three testing sessions a week for four weeks.

The data analysis process will take a minimum of two hours per participant to complete tasks such as marker labelling, data origination, staticial analysis. Following this, results will need to be presented and interpreted before the final discussion and conclusions can be written.

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