# Project description

## Administrative information

### Title

The effect of handgrip on sprint-cycling performance

### Trial registration

This study has been pre-registered at <https://osf.io> with the identifier “4evky”. The registration details can be accessed at <https://osf.io/4evky>

### Protocol version

Version 4.0 of this protocol was created on July 30, 2020.

### Funding

There is currently no external funding for this study.

### Roles and responsibilities

**Principal Investigator (s):** Assoc Prof Glen A. Lichtwark, BSc (Hons), PhD (Human Movement Science)1

Prof Andrew Cresswell

**Co-Investigator(s):** Mr Ross D. Wilkinson, BESS (Hons), Doctoral student (Biomechanics)1

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## Introduction

### Background and rationale

It has been shown that maximal power output is ~8-15% higher in a non-seated posture compared to when seated (Reiser et al., 2002; Hug et al., 2011, Driss and Vandewalle, 2013). Evidence suggests the increase in maximal power when using a non-seated posture is due to a greater contribution of power from muscles in the upper body (Davidson et al., 2005 (Pilot study)). This evidence is supported by the finding that riders activate their upper-body muscles during high-power output cycling to a greater level in a non-seated posture compared to when seated (Turpin et al., 2017). It has been proposed that this upper-body muscle activity is to prevent upward acceleration of the rider's centre of mass, which allows leg extension power to generate greater levels of crank power (Dore et al., 2006). Further insight has been provided recently by the finding that riders raise and lower their centre of mass during specific phases of the crank cycle to amplify instantaneous maximal crank power when cycling in a non-seated posture (Wilkinson et al., unpublished data). The purpose of this study is to quantify the contribution of upper-body muscular and non-muscular power to maximal power output during sprint cycling in both a seated and non-seated posture. The underlying mechanisms possibly associated to changes in maximal power output will be explored using three-dimensional motion capture, instrumented cranks, inertial measurement units, and surface electromyography to measure and analyse the motion, force output, and muscle activity of the rider under each condition.

#### References

﻿Davidson, C. J., Horscroft, R. D., McDaniel, J., Tomas, A., Hunter, E. L., Grisham, J. D., … Thompson, F. T. (2005). The Biomechanics Of Standing And Seating Maximal Cycling Power: 2029 Board #168 3:30 PM – 5:00 PM. Medicine & Science in Sports & Exercise, 37(5). Retrieved from <https://journals.lww.com/acsm-msse/Fulltext/2005/05001/The_Biomechanics_Of_Standing_And_Seating_Maximal.2028.aspx>

Doré, E., Baker, J. S., Jammes, A., Graham, M., New, K., & Van Praagh, E. (2006). Upper body contribution during leg cycling peak power in teenage boys and girls. Research in Sports Medicine (Print), 14(4), 245–257. <https://doi.org/10.1080/15438620600985829>

Driss, T., & Vandewalle, H. (2013). The measurement of maximal (Anaerobic) power output on a cycle ergometer: A critical review. BioMed Research International, 2013. <https://doi.org/10.1155/2013/589361>

﻿﻿Hug, F., Turpin, N. A., Couturier, A., & Dorel, S. (2011). Consistency of muscle synergies during pedaling across different mechanical constraints. Journal of Neurophysiology, 106(1), 91–103. <https://doi.org/10.1152/jn.01096.2010>

Reiser, R. F., Maines, J. M., Eisenmann, J. C., & Wilkinson, J. G. (2002). Standing and seated Wingate protocols in human cycling. A comparison of standard parameters. European Journal of Applied Physiology, 88(1–2), 152–157. <https://doi.org/10.1007/s00421-002-0694-1>

﻿Turpin, N. A., Costes, A., Moretto, P., & Watier, B. (2017). Upper limb and trunk muscle activity patterns during seated and standing cycling. Journal of Sports Sciences, 35(6), 557–564. <https://doi.org/10.1080/02640414.2016.1179777>

### Objectives

If muscles in the upper body contribute more power during non-seated sprinting compared to seated, then the effect of gripping the handlebar on maximal power output should be significantly greater during non-seated cycling compared to when seated.

### Trial design

Repeated measures within-subject design with 2 factors (posture, and handlebar grip) each with 2 levels (Posture: seated and non-seated. Handlebar grip: no grip and grip).

## Methods: Participants, interventions, and outcomes

### Study setting

Neuromechanics Laboratories, School of Human Movement and Nutrition Sciences, The University of Queensland, Brisbane, Australia

### Eligibility criteria

Participants must be apparently healthy adults (18-39 years of age) who self-report riding a bicycle more than once a fortnight for distances exceeding 10 km and competency in riding with clip-in cycling shoes, and who also meet the guidelines set forth by Sports Medicine Australia (SMA).

The latest Adult Pre-Exercise Screening System (APSS) designed by SMA indicates that a medical exam and diagnostic exercise testing are not warranted prior to beginning a vigorous exercise program for apparently healthy individuals who already participate in at least 150 minutes of exercise per week and do not have any signs or symptoms of cardiovascular, metabolic, or renal disease. We will use the APSS to determine if these criteria are met.

### Interventions

Participants will perform 5-s maximal sprints on a cycle ergometer in either a seated or non-seated posture, with either no additional body mass or wearing a weight vest equal to 20% of the their body mass, and either gripping the drops of the handlebar or resting their fists on top of the handlebar.

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**Figure 1.** A schematic of the eight conditions under which participants will perform a 5-s maximal sprint on a cycle ergometer.

### Outcomes

The primary outcome of these interventions will be an acute change in peak maximal power output during the cycling trial. No long-term effects are predicted to occur due to the intervention.

### Participant timeline

Once a participant has contacted a research team member to express interest in the experiment, they will be provided with a Participant Information Sheet. If the individual is still willing and able to volunteer for the study, they will be asked to complete a Sports Medicine Australia exercise screening form, provide Informed Consent and take part in one, 90-minute experimental session. A detailed outline of the experimental procedures and measurement techniques is provided in Section 4.1.

### Sample size

Our target sample size is 16 participants. We will attempt to recruit up to 20, assuming that not all will complete the total task or that some data may be lost due to technical issues. This sample size is based on the time available for our team to complete data collection within a two-month period during the University semester. Further detail of how appropriate statistical power will be achieved with this sample size is provided in Section 4.3.

### Recruitment

Potential participants will be sourced from students, faculty, and staff of the University of Queensland and members of the local community via a combination of flyers, newsletters, and social media (sample advertisements attached). Interested volunteers will be asked to contact the research team via email, social media, or phone. A research team member will then provide further information about the study and answer any questions that the potential participant may have. A research team member will also forward a copy of the participant information statement to the volunteer and they will be offered as much time as they need to decide on their potential involvement in the study. If the volunteer is happy to enrol in the study, they will be invited to attend a testing session at The University of Queensland where they will first be screened for eligibility.

## Methods: Data collection, management, and analysis

### Data collection methods

#### Experimental procedures

Participants will be asked to take part in one, 90-minute experimental session in the Neuromechanics Laboratory located on Level 2 of the Human Movement and Nutrition Sciences building at The University of Queensland St Lucia campus. Upon arrival, investigators will re-inform participants of the research requirements and their right to withdraw at any time without penalty for any reason. The investigator will confirm the participant’s understanding of the experimental procedures by getting participants to explain what is required of them during the session. Then, if willing and able, participants will provide Informed Consent to take part in the research study.

Prior to completing the experimental trials, the participant’s height and weight will be measured using a measuring tape and scales, respectively. The participant’s height will be used to re-create their motion during data analysis. \For any regular cyclists, the seat height and handlebar position of the ergometer (Excalibur Sport, Lode BV, Groningen, The Netherlands) will be matched to their accustomed cycling position. For the remaining participants, the fitting will be standardized to an internal knee angle of 150° and torso angle (trunk relative to horizontal) of 70°. Based on each participant’s preference, minor adjustments to this fitting will be made. Crank length will be set to 175 mm. Participants will wear cleated cycling shoes (SH-R070, Shimano, Osaka, Japan) that clip into the pedals (SH-R540, Shimano, Osaka, Japan).

Participants will then complete a 5-min cycling warm-up at 100 Watts at their preferred cadence. After completing the warm-up, the ergometer will be set to “Isokinetic” mode which ensures the cadence in each trial will stay at a constant rate of 120 revolutions per minute independent of power output. Participants will then be familiarized to each condition by completing a 10-second sub-maximal effort. Once familiarized, participants will complete twelve, 5-second maximal sprint trials in a randomized order. A 3-minute rest period will be given between trials to reduce any potential fatigue effects.

For each trial, muscle activity, crank angle, and crank force signals will be acquired synchronously with motion capture using a 16-bit A/D conversion board (USB-2533, Measurement Computing Corporation, Norton, MA) and Qualisys Track Manager Software (Qualisys AB, Gothenburg, Sweden).

#### Measurement techniques

##### Motion capture

The three-dimensional (3D) position of forty-five passive reflective markers will be collected at 200 Hz using an eight camera, opto-electronic motion capture system (Oqus, Qualisys, AB, Sweden). These markers are lightweight, Styrofoam balls 1cm in diameter coated with a reflective tape. Markers will be secured to the skin using double-sided tape over the suprasternal notch, C7 spinous process, sacrum, and bilaterally over the acromion processes, lateral epicondyles of the humerus, styloid processes of the radius, iliac crests, anterior superior iliac spines, posterior superior iliac spines, greater trochanters, medial and lateral condyles of the femur, and medial and lateral malleoli. Markers will also be secured to the cycling shoe over the calcanei, heads of the 1st and 5th metatarsals and the 2nd distal phalanxes. Lightweight, rigid clusters of four markers will be secured bilaterally to the lateral mid-thighs and lateral mid-shanks using double-sided tape and self-adhesive bandage. A static trial will be collected with the participant standing in a standard anatomical posture before commencing the familiarization trials. The static trial will be used during data processing for kinematic model scaling. The heading (yaw) angle of the ergometer will be determined within the motion capture global coordinate system by placing two markers on the rear support legs of the ergometer. These markers will be used to create a local coordinate system for the ergometer, which will account for any discrepancy with the global coordinate system between trials.

##### Crank angle and forces

Tangential and radial forces at the left and right crank, and crank angle will be recorded at 200 Hz using pre-calibrated, wireless, instrumented cranks (Axis, SWIFT Performance, Brisbane, Australia) attached to the cycling ergometer. The cranks are specifically designed to be a similar weight and shape to regular bicycle cranks.

##### Muscle activity

Surface electromyographic (EMG) activity of eight muscles will be recorded wirelessly at 2 kHz (Myon AG, Baar, Switzerland). Each wireless measurement unit is approximately the size of a matchbox with electrics housed within a water and airtight lightweight plastic casing. Before electrode application, the skin at each recording site will be shaved, abraded, and cleaned to reduce impedance. Bipolar electrodes (Ag/AgCl, Covidien, Mansfield, MA) will then be placed according to SENIAM recommendations. Each signal will then be checked for clarity and strength during an attempted isolated contraction. All cables and electrodes will be secured to the skin using a combination of adhesive tape and self-adhesive bandage to minimize movement artefact.

##### Pelvic motion

A single inertial measurement unit (IMU BlueThunder, iMeasureU, Auckland, New Zealand) will be adhered to the skin using double-sided tape over the sacrum to estimate the pelvic motion of the rider. The IMU Research Application (IMeasureU, Auckland, New Zealand) will be used to capture inertial measurement sensor data at 100 Hz via Bluetooth to an iPad (Apple, California, United States). The inertial measurement unit is approximately the size of a matchbox with electrics housed in a water and airtight lightweight plastic casing. The IMeasureU 9-axis sensor contains an accelerometer, gyroscope, and magnetometer microelectromechanical system technology mounted in a tri-axial arrangement on a small circuit board. The sensor logs acceleration, angular velocities, and magnetic flux data in the three orthogonal planes.

### Data management

Data being collected from the experiment will be explained to the participants during the experimental session. In the event that a participant elects to withdraw from the experiment, all data collected from that participant will be destroyed.

All consent forms will be stored in lockable cabinets in Assoc Prof Lichtwark’s office. All other data will be stored electronically in an unidentifiable manner on University network drives or local computers that are password protected so that only the investigators have access. There is a possibility that de-identified numerical data from the study may be taken to the investigator’s homes on laptops used for data analysis. Computers will be kept in secure locations and only accessible by the investigators via password protection on computers. All research investigators will be informed about the required measures for data security and privacy of study participants.

Results from the experiment published in any format will be available to participants directly from the investigators. All reporting of results will be de-identified data and most likely group mean data. Any media communications will not involve any of the research participants unless express permission is granted from that participant prior to such reporting. Meta-data and other detailed data (e.g. movement patterns and forces recorded from individuals) may also be made available via our University repository (eSpace), however this will be in a de-identified manner (no names or identifiable features to data) that will not be traceable to the participants.

### Statistical methods

The False Positive Risk Web Calculator (version 1.7, http://fpr-calc.ucl.ac.uk/) was used to calculate the alpha level required to control the False Positive Risk at 5% with a sample size of 16, a prior probability for a real effect of 0.5, and an estimated effect size of 1.0. The calculated alpha level of 0.039345 will be used as a threshold to assess the presence of significant main and interaction effects. Whenever a main or interaction effect is found, multiple comparisons will be used to detect the effect of the factor/s at each level. The alpha level will be corrected for familywise multiple comparisons using the Sidak method.

## Ethics and dissemination

### Research ethics approval

Ethical approval will be sought from The University of Queensland’s Human Research Ethics Committee via the submission of a National Health and Medical Research Council (NHMRC) Human Research Ethics Application (HREA). Per the National Statement on Ethical Conduct in Human Research, there will be no interaction with participants or data pertaining to this research study until ethical approval has been granted.

### Protocol amendments

Per the National Statement on Ethical Conduct in Human Research, any amendments to the project will be submitted for approval via the NHMRC HREA system.

### Consent or assent

Potential participants will be informed of the requirements and goals of the study and what they are likely to feel and experience throughout the study via an information sheet. If they are still interested in participating, consent forms will be read and signed by the participant before being involved in the study. All participants will have access to the investigators if they have any questions before, during or after the experiment. Participants will not be paid for their participation in these experiments. Participants will be given as much time as required to decide on participation and reminded that they may also leave the study at any time.

### Confidentiality

Information obtained about each participant will be kept confidential to the extent allowed by law. Research information that identifies the participant may be shared with The University of Queensland Ethics Review Committee and others who are responsible for ensuring compliance with laws and regulations related to research. The information from this research may be published for scientific purposes; however, a participant’s identity will not be given out.

Confidentiality of each participant will be protected before, during, and after the research study by storing Informed consent documents in lockable cabinets, digital copies of these documents in a password-protected folder in a secure UQ server, and all other electronic data in an unidentifiable manner (participant codes i.e. pXXXX) on secure university servers (UQ Research Data Manager) or local computers that are password protected so that only the investigators have access. There is a possibility that de-identified numerical data from the study may be taken to the investigators’ homes on laptops used for data analysis. Computers will be kept in secure locations and only accessible by the investigators via password protection on computers. All research investigators will be informed about the required measures for data security and privacy of study participants. De-identified data will be digitally stored on secure password protected university severs for a minimum of 7 years.

### Declaration of interests

The investigators report no conflicts of interest. The results of this study will be presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

### Access to data

Access to the de-identified research dataset will be made publicly available via an online repository (osf.io) and the University repository (eSpace).

### Ancillary and post-trial care

If participants require medical care because of taking part in this research study, they will be informed to seek medical attention immediately and if it is a medical emergency to first call 000. A First Aid Kit and AED will be kept within the Neuromechanics Laboratory in the case that a person trained in CPR/First Aid is willing to administer care to the participant. Participants will be instructed to contact a research team member as soon as possible to report any adverse events after the experimental session.

### Dissemination policy

Results from the experiment published in any format will be available to participants directly from the investigators. All reporting of results will be de-identified data and most likely group mean data. Any media communications will not involve any of the research participants unless express permission is granted from that participant prior to such reporting. Meta-data and other detailed data (e.g. movement patterns and forces recorded from individuals) may also be made available via public (osf.io) and University repositories (UQ eSpace), however this will be in a de-identified manner (no names or identifiable features to data) that will not be traceable to the participants.

## Appendices

### Informed consent materials

* Participant Information Sheet/Consent Form

### Health screening materials

* Sports Medicine Australia Adult Pre-Exercise Screening System