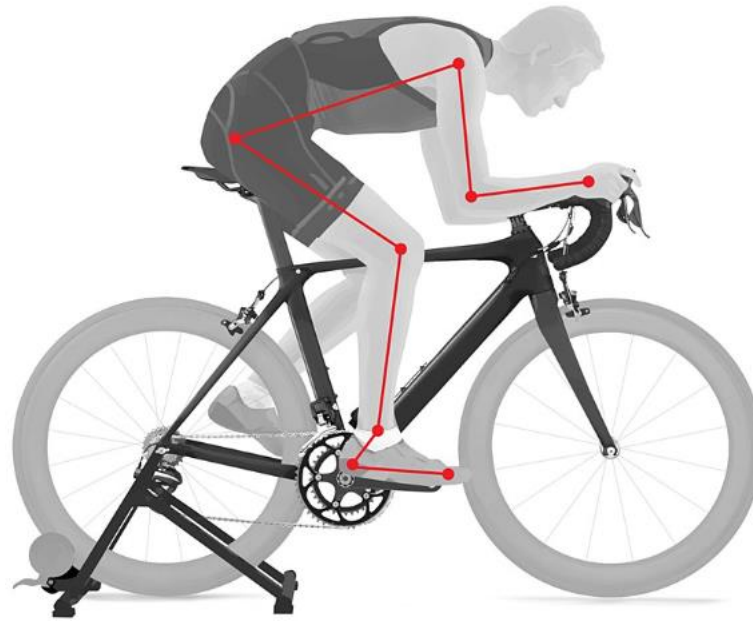




THE EFFECTS OF KNEE ANGLE ON OPTIMUM PEDAL EFFICIENCY SCORE DURING STATIC CYCLING

Gareth Jones: BSc Sports Therapy - 1802873

Module: SHSS5061 - Research proposal



CONTENTS

- Research Question
- Context and rationale for study
- Hypotheses
- Methods
- Ethical considerations
- Proposed timeline
- Limitations
- References

RESEARCH QUESTION

Static bike fitting may improve a cyclist's performance and efficiency (Shen *et al.*, 2018).

- Improvements in pedal efficiency score (PES).
- Reduced risk of injury through improvements in pedal efficiency.
- Improved performance through training consistency.
- Optimum angles may be applied to future bike fitting to enhance performance.
- Current research suggests 25° - 35° knee angle may achieve optimum PES (Quesada *et al.*, 2016).

RESEARCH QUESTION

There is a disagreement within scientific studies to what the optimum knee angle is to achieve PES (Bini *et al.*, 2011; Shen *et al.*, 2018), therefore this study will have the following objectives.

- Collect PES data at angles of 25°, 30°, 35° knee angle in line with current research.
- Analyse the results to establish the optimum angle to achieve PES.
- Discuss the findings in line with current research.
- Kinesiology discussion based on the results.

CONTEXT & RATIONALE FOR STUDY

- Previous studies have stated that a 5% increase in saddle height may affect knee kinematics by as much as 35% (Bini *et al.*, 2011).
- Achieving optimum saddle height is believed to improve pedal efficiency and reduce the risk of future knee injuries (Bini *et al.*, 2011).
- A recent study has stated that 85% of chronic cycling injuries are linked to poor technique and incorrect bike position (Shen *et al.*, 2018).
- PES can be tested with reliability on the Wattbike at varied knee angles (Cox, 2017).

CONTEXT & RATIONALE FOR STUDY

- PES (Figure 1) is determined by positioning and pedal stroke technique (Cox, 2017).
- PES is measured in three colours, also using a scoring system to match the colours. Red (0-59), amber (60-69), and green (70-80 (Cox, 2017).
- Green is considered optimum PES with scores ranging between 70-80, with 75 deemed optimum (Cox, 2017).

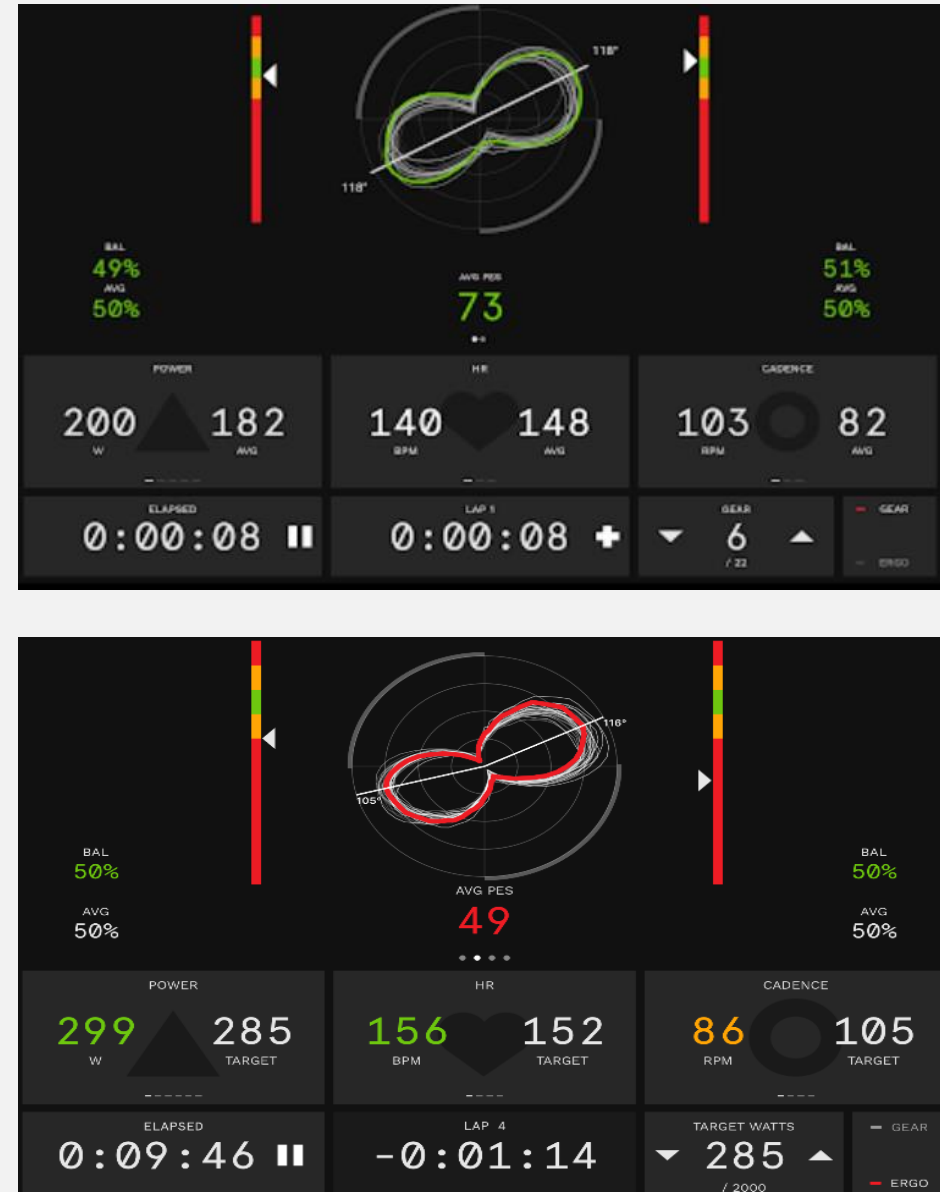


Figure 1. Pedal effectiveness score (Cox, 2017).

HYPOTHESES

There is limited evidence to suggest that one set angle will achieve the main objective, with current research suggesting 25° to 35° (Quesada *et al.*, 2016).

- Null Hypothesis - There is no association between the knee angles to achieve optimum PES during static cycling.
- Hypothesis - There is evidence that 30° knee angle will achieve optimum PES during static cycling.

METHOD - PARTICIPANTS

12 participants

6 male & 6 female

Age: 18 - 65

Injury free

Physically fit - PAR-Q

METHOD - RESEARCH DESIGN

Source	Method	Outcome
(Bini <i>et al.</i> , 2011).	Range of knee joint flexion to achieve varied knee angles using a goniometer.	Comparing varied methods to find optimum saddle configuration, found that 25-30° was optimum for PES.
(Quesada <i>et al.</i> , 2016).	2D and 3D bike fitting with kinematic analysis.	Recommended optimum knee angles of 25 to 35° may be too large, and negatively affect performance.
(Wainwright, Cooke, and O'Hara, 2017).	Wattbike to test re-test reliability.	The Wattbike re-test ability was found to be within 2% reliability between 10 different Wattbike's.

METHOD - RESEARCH DESIGN

- This study will utilise a static fitting process using a Wattbike (Figure 3). PES will be analysed to find the most effective knee angle per individual participant over the varied assessments.
- Wattbike has been regarded an efficient and accurate assessment tool in previous studies with Re-test reliability within 2% (Wainwright, Cooke, and O'Hara, 2017).
- knee angle methods are frequently used to achieve saddle height in cyclists, and are considered to be an accurate measurement during bicycle fitting (Millour *et al.*, 2019; Bateman, 2014).

METHODS

PROTOCOL

- Participants will be set at three relevant knee angles using the goniometer (Figure 2 (Millour *et al.*, 2019)).
- The goniometer measurements will be taken from the same bony prominences on all participants to standardise the measurements (Figure 3), which have been used to analyse movement in previous studies (Jia-Da *et al.*, 2017).

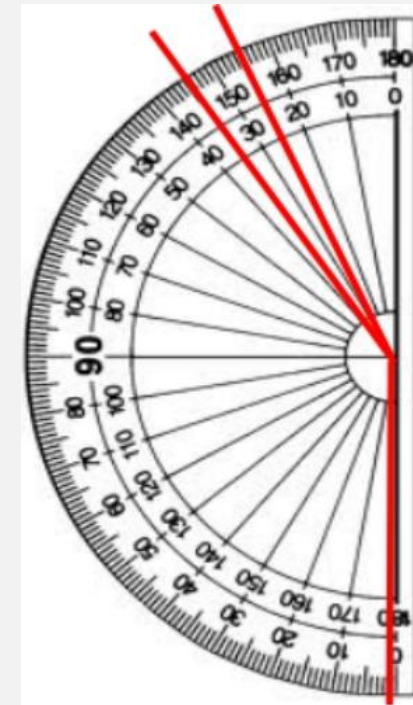


Figure 2. Goniometer, and angles of 25 - 35 degrees (Jia-Da *et al.*, 2017).

METHODS PROTOCOL

Greater trochanter (1)
Lateral femoral epicondyle (2)
Lateral malleolus (3)



Figure 3. Wattbike, and bony prominence markings (Jia-Da *et al.*, 2017; Cox, 2017).

METHODS

PROTOCOL

- The knee angles will be taken when the crank arm is in line with the seat post, from the bottom of the crank arm to the top of the seat (Figure 4 (Bini *et al.*, 2011)).
- Most research on saddle height evaluated pedal efficiency based on steady state cycling and fixed power or cadence (Bini *et al.*, 2011).

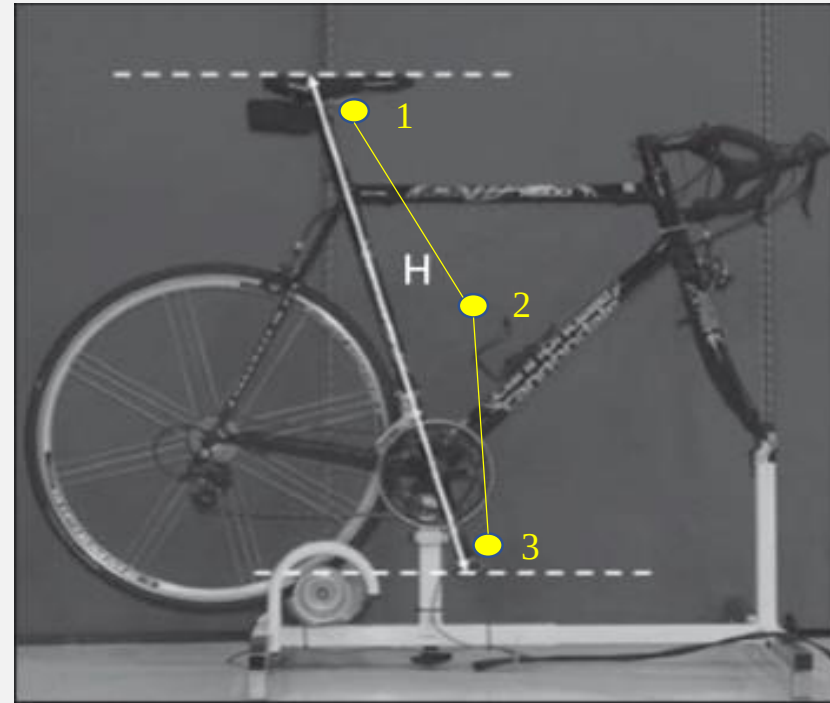


Figure 4. Cyclists position during knee angle (Bini *et al.*, 2011).

METHODS

PROTOCOL

- Participants will be set in a neutral saddle set back position, with the patella in line with the pedal spindle with foot at 3 o'clock (Figure 5 (Bini *et al.*, 2013), a laser level will be used to establish the position.
- Participants will use a cadence of 80 RPM on all 3 assessments at the varied angles, Magnetic level 0, air level 8, with PES recorded for 3 minutes during each assessment (Domalain *et al.*, 2016).

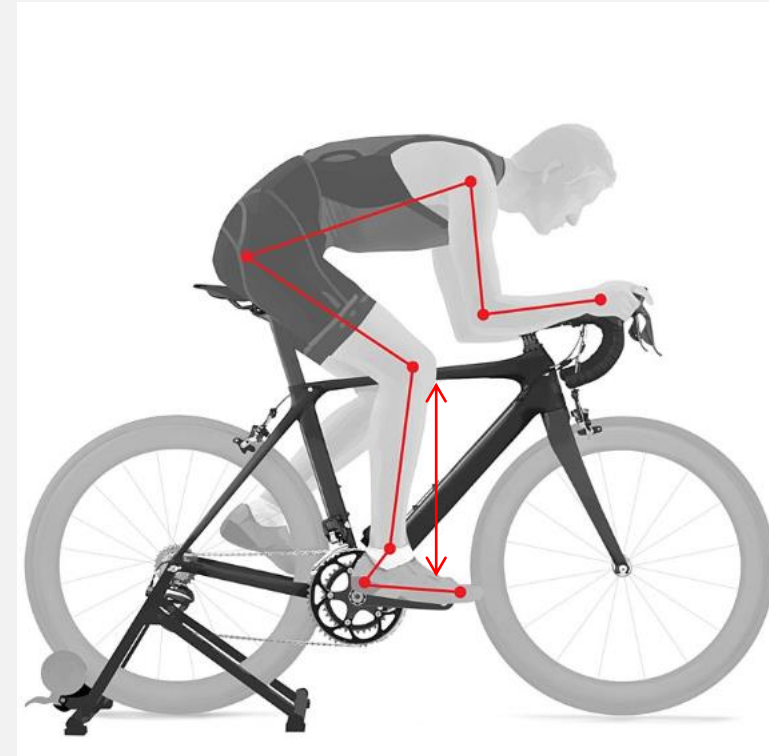


Figure 5. Saddle set back position (Bini *et al.*, 2013).

METHODS - DATA ANALYSIS

- Case control study.
- Excel.
- SPSS Statistics.
- Data collected from the assessments will be analysed using SPSS to establish any correlation between varied knee angles and PES.

ETHICAL CONSIDERATIONS

- The data will be used by the principle researcher during the research and assessments.
- Individual participant data will be made available to the participants on written request.
- Data will be stored securely for 7 years post the date of assessment.
- All individuals will remain anonymous throughout assessment.
- Participants will not be subjected to any harm during assessments.
- Feedback

ETHICAL CONSIDERATIONS

- Each participant will need to give consent prior to any assessment, whilst also completing PAR-Q and informed consent.
- Participants will be allowed to withdraw consent at any time without notice, which removes them taking part in any further assessments.
- Risk assessments will be conducted prior to any assessment to ensure participants safety, this will establish any possible risk of injury or hazardous conditions prior to assessments.

PROPOSED TIMELINE

12 participants
3 x PES assessments
Weeks 0-3

Data analysis
Weeks 3-9

Research and final report
Weeks 3-11

PROPOSED TIMELINE

[illegible]

LIMITATIONS

- This study is limited to using practical equipment for angular assessments such as the goniometer to achieve the relevant knee angles.
- This research is limited to a static fitting process, using the Wattbike for pedal efficiency data.
- Participants experience in cycling may be limited, however the study will need varied experience to establish the affects on a wide variety of individuals.
- The use of toe clips to assess PES may affect cycling technique.

REFERENCES

Bateman, J. (2014). Influence of positional biomechanics on gross efficiency within cycling. *Journal of Science and Cycling*, **3**(2), pp. 4.

Bini, R., Hume, P., A. and Croft, J., L. (2011). Effects of bicycle saddle height on knee injury risk and cycling performance. *Sports medicine*, **41**(6), pp. 463-76.

Bini, R., Hume, P., A., Lanferdini, F., J. and Vaz, M., A. (2013). Effects of moving forward or backward on the saddle on knee joint forces during cycling. *Physical therapy in sport*, **14**(1), pp. 23-7.

Cox, P. (2017). *General watt bike cycling position and set up*. (Accessed: 08/12/2019). <https://support.wattbike.com/hc/en-us/articles/115001849069-General-Wattbike-Cycling-Position-and-Set-Up>

Domalain, M., Menard, M., Decatoire, A. and Lacouture, P. (2016). Bike fitting: finding an optimum between performance and overuse injuries prevention? Influence of saddle fore-aft position on knee joint forces. *Journal of Science and Cycling*, **5**(2).

REFERENCES

Jia-Da, L., Tung-Wu, L., Cheng-Chung, L., Mei-Ying Kuo, Hsu, H. and Wu-Chung, S. (2017). Soft tissue artefacts of skin markers on the lower limb during cycling: Effects of joint angles and pedal resistance. *Journal of biomechanics*, **62**(1), pp. 27-38.

Millour, G., Duc, S., Segui, D., Theo, O., Frederik, P. and Bertucci, W. (2019). Relationship between preferred saddle height and pedalling kinematics in professional cyclists. *Journal of science and cycling*, **8**(2), pp. 13-14.

Quesada, J., I., P., Jaques, T., C., Bini, R., R. And Carpes, F., P. (2016). Importance of static adjustment of knee angle to determine saddle height in cycling. *Journal of science and cycling*, **5**(1), pp. 26-31.

Shen, G., Zhang, S., Bennett, H., J., Martin, J., C., Crouter, S., E. and Fitzhugh, E., C. (2018). Effects of knee alignments and toe clip on frontal plane knee biomechanics in cycling. *Journal of sports science & medicine*, **17**(2), pp. 312-321.

Wainwright, B., Cooke, C., B. and O'Hara, J., P. (2017). The validity and reliability of a sample of 10 Wattbike cycle ergometers. *Journal of sports sciences*, **35**(14), pp. 1451-1458.