

Project Title: The relationship between impairment, functional ability and performance in Para-Equestrian dressage riders: evidence-based recommendations for revising current Para-Equestrian Classification systems.

Proposed Mode of Research:

Work Package 1 (Objectives 1 and 2): Rapid Review

Work Package 2 (Objective 3): Qualitative Research Methods

Work Package 3 (Objectives 4 and 5): Experimental/ Quantitative Research Methods

Aims and Objectives:

Aim: To develop a comprehensive understanding of the effect of different physical impairment types on performance in dressage, which will inform recommendations for an evidence-based, sport-specific Classification system for Para-Equestrian dressage.

Objectives:

Objective 1: To review current literature (scientific and grey) relating to the functional skills and abilities required for athletes to participate and perform successfully in the sport of dressage.

Objective 2: To review current literature (scientific and grey) to examine the effects of impairment types outlined by the IPC/FEI on functional skills and abilities required for dressage (as defined in Objective 1) and to review current eligibility criteria and assessment methods.

Objective 3: To explore the level of agreement between literature, the current FEI Classification system, and the opinions of Para-Equestrian athletes, coaches and other stakeholders in relation to the functional demands of dressage, current eligibility criteria and assessment methods for different impairment types.

Objective 4: To quantify functional skills and ability, as defined from literature (Objective 2) and expert opinion (Objective 3), in equestrian athletes/para-athletes, using kinematic and kinetic measurement tools during ridden tests on a horse and a riding simulator and to compare functional skills and ability to clinical test outcomes.

Objective 5: To develop evidence-based recommendations for informing the objective assessment of: eligible impairments, minimum impairment criteria, functional sport-specific ability, compensating aids and the development/ validation of current methods for defining sports classes using information from Objectives 1 – 4.

Synopsis:

The proposed study will employ qualitative and quantitative methods to investigate and define measures of impairment, measures of performance and the strength of association between impairment and activity limitation, as described by (1). The proposed mixed methods approach will ensure that current literature and the opinions of Para-Equestrian athletes and stakeholders play a significant role in informing study design and overall development of FEI classification systems. Advanced quantitative methods will provide novel biomechanical data from able-bodied and Para-equestrian athletes across all eligible impairments. Findings will provide evidence to inform the classification of athletes and evaluate the impact of impairment on dressage performance. The proposed study will ensure that the FEI Para-Equestrian Classification system for dressage is in line with the IPC Classification Code's mandate for evidence-based systems of classification.

Background:

To minimise the impact of impairment on the outcome of competition, all sport-specific classification systems must develop scientific evidence to define: eligible types of impairment, eligible impairment severity and the extent of activity limitation caused (1). The current FEI Para-Equestrian Classification System is based upon the work of Dr. C. Meaden (2), which was developed in the 1990s, but the assessment methods have yet to be scientifically evidenced. Furthermore, the FEI Classification system does not classify eligible impairments based on the extent of "activity limitation" caused. Revision of the current system will therefore require an empirical examination of the methods used to classify eligible impairments and their impact on performance in Para-Equestrian dressage. To do this, a comprehensive understanding of fundamental skills, abilities and body positions required for sport-specific performance, and the specific body structures that are impacted must be defined.

Horse-rider coordination dynamics is an increasing area of interest, but limited information is currently available for defining the fundamental skills required for performance in dressage. Studies have reported differences in movement and muscle activity patterns between experienced and inexperienced riders, with experienced riders exhibiting greater head and trunk stabilization (3, 4), anterior pelvic tilt (5), consistency of movement (4, 6) and horse-rider coordination dynamics (4, 6) than inexperienced riders. This information has provided insight into motor control in riders and has led to suggestions for skill development in inexperienced riders (5). In line with the IPC's Classification Code, normative baseline data will be especially important for defining fundamental skills required for dressage, and for developing assessment methods for quantifying these performance traits.

Recent advances in biomechanics research allow many opportunities for revision and/ or validation of the current FEI Classification system. Advanced methods and techniques could provide quantitative data from ridden tests, whilst riding simulators may offer a method for standardised, objective, sports-specific assessments. Data obtained from such tests may then be compared with current and alternative relevant clinical tests. The need for further research to develop normative biomechanical data from equestrians has been highlighted and would form the basis for defining and assessing impairments, activity, and activity limitations for evidence-based Para Equestrian classification systems. This is the first step to ensuring that objective impairment and activity limitation assessments promote equity within and between classes in Para sport.

Expected Research Contribution:

Previous studies have investigated biomechanical differences between elite and non-elite able-bodied riders and the physical effects of therapeutic riding/ hippotherapy on disabled riders. However, no studies have extensively investigated or defined the fundamental skills or activities required to successfully perform in the sport of dressage. As such, the impact of impairments on dressage is not comprehensively understood. This study will, therefore, offer an original and significant contribution to knowledge. The evidence obtained will be used to recommend:

- Objective measurements of performance for dressage
- Eligible impairments for Para-Dressage
- Reliable measures of impairment, based on their impact on fundamental skills and activities for performing dressage (performance measures).
- Minimal impairment criteria for eligible impairments.

The Proposed Methodology:

Prior to the commencement of each work package (WP), ethical approval will be obtained from the UCLan Ethics Committee. In light of the wide variety of eligible impairments for Para-Equestrian dressage, participants from each Grade with a wide range of impairments will be recruited.

Work Package 1: Rapid Reviews

In this WP, we aim to comprehensively explore current knowledge on the fundamental skills/ activities required for dressage (performance measures), the possible impact of various impairments on these performance measures (activity limitation) and the assessment measures available for measuring eligible impairments for Para-Dressage. In comparison to systematic reviews, which generally require 6 – 12 months and multiple researchers to complete, rapid reviews accelerate the review process and are commonly employed in situations where evidence is required for clinical urgency, demands for uptake of technology and where limited time and resources are available (8). Previous studies have compared findings from systematic and rapid reviews, reporting that the truncated search strategy of a rapid review is unlikely to effect the final recommendation of a review (8). Two focussed, rapid reviews will therefore be conducted to ensure that the aims of WP1 are fulfilled in accordance with restrictions on time and resources (staff time, budget etc.). The paucity of scientific literature surrounding determinants of performance in various sports has been highlighted by (7). To account for this, both scientific and grey literature will be included in the search strategy for both rapid reviews. Standardised methodologies for rapid reviews have not been described. Therefore, the methods employed in this WP will be reported in a transparent manner to ensure repeatability and reliability of findings. Information gathered from this WP will inform WP 2 and 3.

Review 1 will examine literature on the horse-rider interaction during gaits and movements required for dressage. The review will explore whether current knowledge can be used to define the determinants of sports performance (performance measures) for dressage. There has only been one widely published systematic review investigating performance demands of equestrian athletes (9). However, this review did not focus on dressage riders and did not include grey literature in its search strategy. The review proposed in this WP will identify the functional skills and abilities required principally for able bodied athletes to perform successfully in the sport of dressage (although emerging information from Para-athletes will not be excluded) and the resulting desired locomotion patterns of the horse that quantify that success (performance outcome measures).

It is envisaged that Equine Science student(s) may conduct pilot work during Year/ WP 1, to quantitatively investigate rider performance measures using the Racewood riding simulator. This pilot work could form a dissertation project(s) and would examine performance measures from able-bodied riders (of varying levels or elite level) during a pre-defined ridden test on the Racewood riding simulator. Force, centre of pressure (COP), and rein tension data will be collected from the riding simulator. Depending on the student and resources available, 3D kinematic data may also be collected. Rider performance data will be analysed against current competition dressage scores using multiple linear regression to obtain key determinants of performance for dressage. This pilot work would be used in accordance with findings from Rapid Review 1 to inform WP 2 and 3.

Review 2 will examine the literature on validated measures of impairment, which are relevant to eligible impairment types, performance measures and activity limitations for Para-Dressage. This information is vital to underpin the selection of outcome measurements to evaluate rider performance and is likely to influence classifications. This review will consider literature from equestrianism, but will also be expanded to evaluate and learn from literature on other Para sports.

Work Package 2: Interviews

In this work package we aim to use qualitative methods to explore the views and experiences of Para-athletes and stakeholders. This type of involvement will ensure that the views and experiences of Para stakeholders are considered and used to inform the development of Classification systems. Semi-structured interviews will be conducted to explore opinions and experiences of the current classification system, perceived performance measures and the impacts of impairment on performance measures in Para-Dressage. **Methods:** Interviews will be conducted and recorded at International Para-Equestrian dressage competition (s) over a one-year period. The United Kingdom is host to two CPEDI3* events (Hartpury College and Bishop Burton) and it is envisaged that interviews will be conducted at these events. Telephone interviews will also be used to collect sufficient data. In addition, if the timescale is favourable it is envisaged that interviews could also be conducted at the World Equestrian Games. **Data analysis:** Interviews will be recorded and transcribed verbatim. Data will be coded and analysed using NVIVO software. Thematic analysis will be employed to identify key themes within the data. The key themes emerging from these data together with the findings from the systematic reviews will inform the final design of WP3 with respect to performance outcome measures, impairment measures and clinical tests to be tested.

It is envisaged that Equine Science student(s) may conduct pilot work to validate methods for collecting horse performance measures during Year / WP 2. It is also envisaged that clinical student(s) (UCLan Sports Therapy or Physio – possibly students from equivalent courses at Hartpury?) may pilot test new, or less familiar, impairment measures for validity. These pilot studies could form dissertation projects and would be used to validate testing methods in preparation for Year/ WP 3.

Work Package 3:

This WP aims to measure impairment severity (using current FEI assessment measures and those outlined in Systematic review 2) and identify key determinants of performance in dressage. WP3 will employ quantitative research methods to investigate factors which determine overall performance in dressage by examining the horse-rider interaction during ridden tests. A riding simulator will be used to biomechanically define functional skills and ability of riders to execute key activities required for overall performance in dressage. Clinical tests identified by WP1 and/or subjectively evaluated as relevant by WP2 will be used to explore functional ability and severity of impairment in participants.

These data will then be collated and used to objectively determine if, how and to what extent impairment severity influences riding performance. This will be accomplished using a three-part study, which will utilise Para-Equestrian Dressage athletes and experienced able-bodied riders. In accordance with Tweedy et al. (7), data from able-bodied riders will be used to develop a normative dataset for comparison with Para riders.

Participants: Due to the complexity of ability limitation of Para-athletes a large sample of the UK population of Para dressage riders is desired. Ideally, a minimum of 10 experienced able-bodied dressage riders, competing at Prix St. George or higher, and 10 classified Para-Dressage riders (Confirmed (C) Grade Status) from each Grade will be recruited for the study.

Ridden tests (measures of overall performance): The assessment of overall performance in dressage is complex, as performance is multi-factorial and is dependent upon communication between the horse-rider dyad. The performance of the horse can be quantified as the dressage score awarded by the judge in relation to specific movements. Thus, overall performance in dressage may be measured by specific activities, which quantify the effectiveness of the rider to influence the performance of the horse. Kinematic data will therefore be collected from horses ridden by participants during a ridden training/competition session to quantify the performance of the horse. This will be achieved by quantifying consistency (i.e. stride frequency, stride duration, velocity, stride length), accuracy (i.e. transitions, location of movements within the arena), and expression (trunk and limb elevation) of movements described in Para-Dressage tests. **Data Collection:** Data collection sessions will be based on Observation assessments, which are currently used for FEI Classification. Data will be synchronously collected throughout a dressage test using non-invasive IMU and GPS sensors (Delsys Inc., USA & RidersMate, UK), in accordance with methods described by Pfau et al., (10).

Simulator tests (measurements of sport-specific functional ability): Kinematic and kinetic data will be collected from participants during simulated riding using a Riding Simulator that is controlled by the rider using leg and rein aids (Racewood Ltd., UK). This offers a reliable, ecologically valid method for data collection, which will standardise the movement experienced by all participants. **Data Collection:** 3D kinematic data will be collected from arm, leg, trunk and pelvis segments using a motion analysis system (Qualisys AB, Sweden). Force, centre of pressure (COP), and rein tension data will be collected from the riding simulator. Each participant will execute pre-defined gaits and movements relevant to a dressage test. Data will be synchronously collected for each gait and movement executed by the rider. It is expected that compensatory aids will be used in this test, as the data may then be directly comparable with the data from ridden tests.

Note: The Riding Simulator is intended to be used as a research tool and we are not advocating that this will be implemented into the FEI Classification System.

Clinical tests (measurements of impairment): Participants will undergo current methods of physical and observational assessments, as defined by the FEI Classification system and also a battery of robust clinical assessments identified by WP1 and WP2. These are expected to include, but are not limited to objective, ratio scaled measurements of strength, coordination, balance, ROM, sensory and reaction speed tests. All riders will perform all tests for this experiment, although it is recognised that in some cases, this may not be possible.

Data Analysis:

1) Quantitative measures of consistency, accuracy and expression obtained from the horse during a dressage test will be analysed against the overall dressage score using multiple linear regression to obtain key determinants of performance for dressage.

2) Kinematic and kinetic measures obtained from riders performing pre-defined gaits and movements relevant to a dressage test on the simulator will be analysed against key determinants of performance, as determined from statistical analysis in 1), using multiple linear regression to quantify key activities that influence performance outcomes.

3) Quantitative measures of impairment will be analysed against key activities that influence performance outcomes, as determined from statistical analysis in 2), using multiple linear regression to determine dressage specific activity limitations.

4) In the event that a substantial number of measures of impairment are found to relate to key activities that influence performance, as defined in 3), this will be further investigated using an exploratory factor analysis. This will provide insight into the number of clinical tests necessary for classifying the diversity of impairments exhibited by Para-Equestrian athletes.

Illustrative example of possible outcomes from Work Package 3:

From the ridden tests it is identified that stride length, transition velocity and trunk elevation are the key determinants of performance in dressage (stats test 1).

These are tested against riders' functional ability on the simulator and it is established that consistent rein tension over the entire test duration, precise COP location during transitions and independent pelvic to trunk motion have the strongest relationship with these key determinants of performance (stats test 2).

The battery of clinical tests (identified from WP1 and WP2) are then evaluated against these measures of functional ability (stats test 3). The tests that are identified from this analysis that are strongly associated with impairment measures are grip strength, the unilateral upper limb reciprocal tapping test, the Wolf Motor Function test and the Balance Evaluation Systems test.

These tests are therefore recommended as measurements of dressage specific impairment for the classification of Para-athletes.

Work Plan:

	Milestone	Specific Tasks	Duration	Other activities
Work Package 1	Review 1	Define search strategy, inclusion/exclusion criteria. Conduct search.	2 weeks	Equine student(s): Pilot test rider (able bodied) performance measures on riding simulator 1 year project (x2)
		Select studies for inclusion based on criteria.	1 month	
		Data extraction/quality assessment of studies.	1.5 months	
		Data synthesis	1 month	
		Writing up	2 months	
Review 2	As above			
Work Package 2	Interviews (UK)		1 month	Equine student(s): Pilot test horse performance measures 1 year project (x2) Clinical student(s): Pilot test new or less familiar impairment measures for validity 1 year project (x1-3)
	Interviews (International)		1 month	
	Interviews (telephone)		Ongoing over 2 months	
	Thematic analysis	Transcription	6 months (ongoing)	
		Data coding/analysis	3 months	
Writing up	1 month			
Work Package 3	Data Collection	Participant recruitment	2 months	
		Clinical assessments	4 months	
		Ridden tests (simulator)		
		Ridden tests (horse)		
	Data analysis	Data processing and analysis	3 months	
		Statistical analysis		
Development of recommendations	Writing up	3 months		

Staff:

Dr Lindsay St. George is a post-doctoral researcher. She has experience in equine and human biomechanics, qualitative analysis, has assisted on a large health-based systematic review and a study exploring the biomechanical effects of therapeutic riding.

Dr Sarah Jane Hobbs has extensive experience in equine and human biomechanics and project management.

Dr Rachel Stockley is a chartered human physiotherapist with extensive experience of working with patient groups in clinical and research settings.

Dr Clare Thetford is an experienced qualitative researcher in health and social care, focussing in particular upon vision impairment.

Prof. Hilary Clayton has a wealth of experience in Dressage as a rider, trainer and biomechanist and recently assisted the USDF in re-writing their test descriptions.

Dr Jonathan Sinclair is a biomechanist and statistician who has an outstanding research track record.

Dr Jane Williams is an experienced equestrian researcher working on horse and rider projects related to analysing performance.

Dr Katheryn Nankervis is the equine resources manager at Hartpury College and has extensive experience of horse and rider testing for research projects.

Dr Stephen Draper is a highly experienced exercise physiologist and quantitative researcher with a background in elite sport science.

Travel:

Travel is required for WP2 to attend International Para-Equestrian competitions, where interviews will be conducted (Hartpury College or Bishop Burton and one competition held abroad). Annual travel from the USA will also be required for Prof. Hilary Clayton. Finally, travel to data collection sessions where the Racewood Simulator is located for both researchers and participants will be required. It is envisaged that this will be at either (Hartpury College or Rest Harrow Equestrian).

Equipment:

Funding will be required to obtain the GPS tracking system required for WP3, Part 2. Purchase of a dynamometer will be required to examine alternative assessment methods for muscle testing in WP3, Part 1. Funding will also be required to hire the RS for WP3.

Clinician fees:

It is currently not possible to estimate potential fees for experienced clinicians to either conduct clinical tests included in WP3 or assist the Para-athletes taking part in WP3. These expenses would need to be negotiated in Year 3.

FEI Support:

The team would require support from the FEI with regards promotion of the studies to engage Para-Equestrian community, particularly with regards recruitment of participants. An agreement may be required to allow quantitative data to be collected from dressage tests performed during competition.

References:

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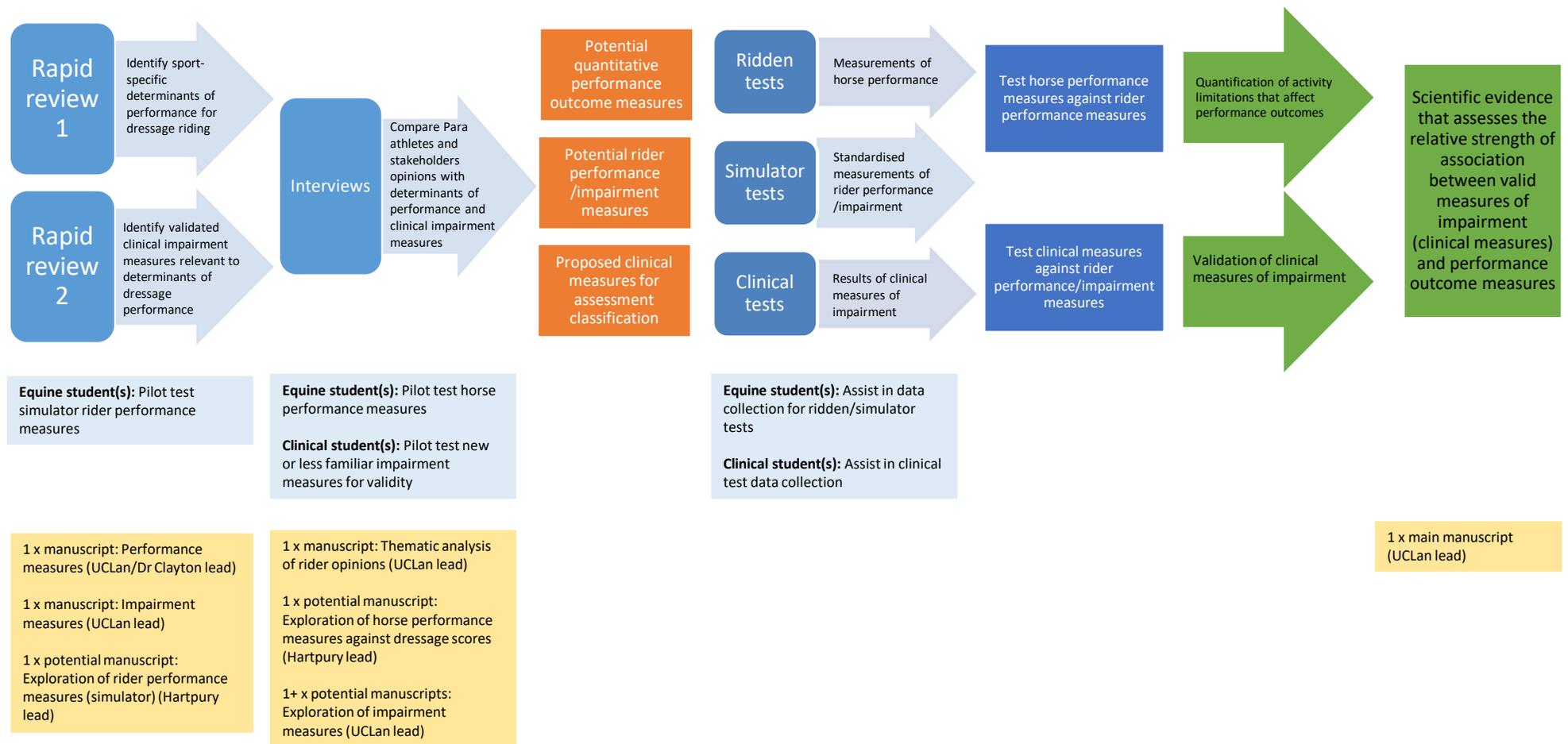


Figure 1: Flow chart summarising the methods and outcomes for the proposed study.

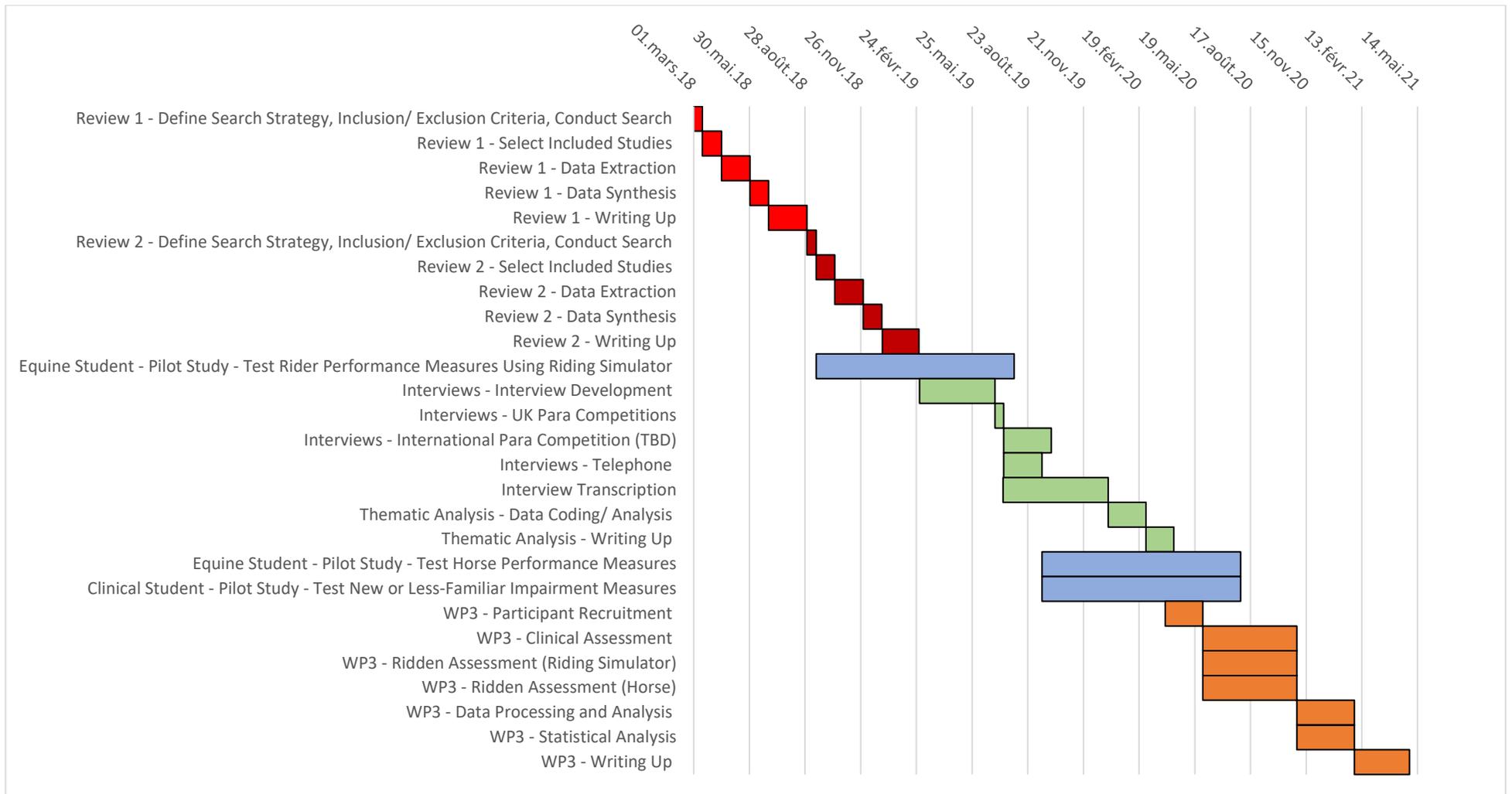


Figure 2: Project proposed timeline