



University of
Central Lancashire
UCLan



HARTPURY

Para Dressage Classification Research

Clinical Measures Training Manual

Produced by:

Dr Rachel Stockley PhD MSc BSc FHEA

Jill Alexander MSc BSc (Hons) MSST MSMA PGCTHE FHEA

Dr Sarah Jane Hobbs PhD BEng (Hons) PGCLTHE/Res Sup FHEA

Contents

	Page Number
1) Background to the project	2
2) Context for the clinical testing	3
3) Clinical measures	4
i) Function in Sitting Test (FIST)	4
ii) SARA	6
iii) Trunk Impairment Scale (TIS)	9
iv) Modified Ashworth Scale (MAS)	12
v) Hand Held Dynamometry (HHD)	14
4) References	17

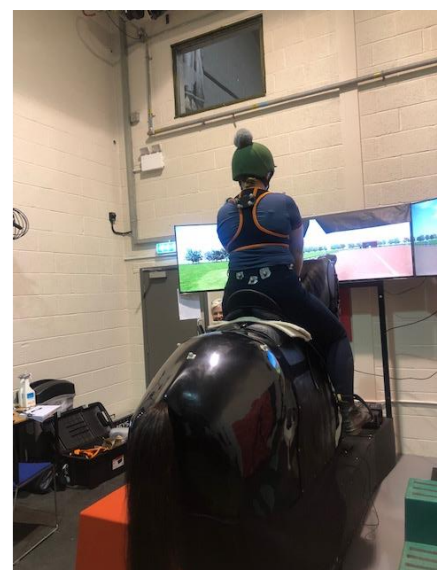
1) Background

In Paralympic sports, all athletes are classified into sports classes based on the impact of their impairment on sports performance. In 2007, the International Paralympic Committee (IPC) published the IPC Classification Code, which amongst other things, mandated the development of evidence-based classification systems across all Para sports. The FEI has therefore prioritised the research and development of a strong scientific evidence-base for their classification system.

Research began in 2018. Our initial work was focussed on conducted a scoping review to identify, from the scientific literature, objective measurements of horse performance in dressage and the functional abilities of the rider that may predict elite dressage performance. The review highlighted a number of potential performance measures that could be tested in the Para dressage population. A second scoping review was also conducted in parallel, which sought to identify objective, valid and reliable clinical tools for measuring eligible impairments for this testing phase. The clinical measures that we have identified in this training manual were chosen for the study based on this review.

In the second phase of the project, athlete and stakeholder input was collected using semi-structured interviews to provide further insight into key determinants of sport-specific performance and the impacts of impairment on performance in Para dressage. We wanted to ensure that the views and experiences of Para stakeholders were considered and used to inform the development of the classification system. A group of thirty Para dressage athletes and stakeholders from various countries were interviewed between May and October 2019.

In the final phase of this research project, we aim to quantify performance measures, as defined from our first scoping review and expert opinion from our interview study, using biomechanical measures during ridden tests on a simulator. Clinical impairment measures, as defined from our second scoping review will also be collected and will be used to investigate the impact of impairment on performance in Para dressage. Overall, this project will inform recommendations for an evidence-based, sport-specific classification system for



Para dressage, which is in line with the IPC Classification Code's mandate for evidence-based systems of classification.

2) Context for the clinical testing

The clinical tools that were identified from our scoping review to use in the final phase of the project were chosen because of their potential ability to indicate an Athlete's capacity, which should strongly predict their activity limitations and performance during their sport. In addition, that they have robust psychometric properties (most notably reliability and validity) in populations with eligible impairments for Para dressage and that they appear practically suitable for classification purposes. We will use these tools to test both Para and able-bodied athletes during this testing phase. As part of our pilot testing, we also investigated the current tests used in classification with UK classifiers. Although the test phase will not include classification tests, current classification information will be compared together with clinical tests in the final analysis.



We have identified a number of test periods over the coming weeks and months to test the Para and able-bodied athletes. We envisage testing Para athletes from each grade and from a range of nationalities at Hartpury University. The testing will involve initially a short, simulated ridden test, followed by the suite of clinical tests (either on the same day or on an alternative day). We have prepared appropriate worksheets for each athlete that can be completed on the day of

testing. We have also secured space in the Rehab Centre for conducting the clinical tests and intend to support physiotherapists performing the testing by having helpers/scribes to input the results.

The clinical tests will be grouped in relation to starting position, which should help athletes who fatigue more easily. FIST, TIS and SARA (except for heel to shin slide) will be administered in a random order first. Following this, joints that can be tested in sitting for MAS will be administered first (elbow and shoulder), followed by HHD (elbow and shoulder). HHD for the trunk will be tested next followed by remaining tests in supine.

3) Clinical measures

i) Function in sitting test (FIST)

This test has 14 items. All except the 3 nudge items are ordered by difficulty, so individuals should perform them in the order presented in the test.

Please note: Nudges should be randomly inserted into the test by the therapist and multiple attempts for each item are acceptable although they should be limited to a reasonable number (2 or 3) to minimize testing effects and fatigue.

The individual should be prompted to attempt with/without hands to improve performance, or to ensure full movement through the task. It is preferable that you score the patient's first attempt, if possible.

Prior to each individual item:

Give the patient instructions and demonstrate the task if needed.

Reposition the patient as needed before each item so they are in the standard position.

Further Information

More detail is available here: <https://www.samuelmerritt.edu/fist/items>

There is also a video demonstration here:

https://www.youtube.com/watch?v=3rUpHUmeY_c

FUNCTION IN SITTING TEST RESULTS

FIST TEST ITEM		Date:
1/2 femur on surface; hip and knees flexed to 90° □ used step/stool for positioning & foot support		
Randomly Administered Once	Anterior Nudge: superior sternum	
	Posterior Nudge: between scapular spines	
	Lateral Nudge: to dominant side at acromion	
Static Sitting: 30 seconds		
Sitting, shake 'no': left and right		
Sitting, eyes closed: 30 seconds		
Sitting, lift foot: dominant side, lift foot 1 inch twice		
Pick up object from behind: object at midline, hands breadth posterior		
Lateral Reach:	use dominant arm, must off-weight the opposite buttock, but need not lift it off the surface.	
Forward reach: use dominant arm, clear opposite ischial tuberosity		
Pick up object from floor: from between feet.		
Posterior scooting: move backwards 2 inches		
Anterior scooting: move forward 2 inches		
Lateral scooting: move to dominant side 2 inches		
TOTAL (/56):		0
Administered by:		
Notes/comments:		

Scoring key:

4	Independent (completes task independently and successfully)
3	Verbal cues/increased time (completes task independently & successfully and only needs more time/cues)
2	Upper extremity support (must use UE for support or assistance to complete successfully)
1	Needs assistance (unable to complete w/o physical assist; document level: min, mod, max)
0	Dependent (requires complete physical assist; unable to complete successfully even w/physical assist)

ii) SARA

The SARA is a tool for assessing ataxia. It has eight categories with accumulative score ranging from 0 (no ataxia) to 40 (most severe ataxia). When completing the outcome measure each category is assessed and scored accordingly. Scores for the eight items range as follows:

- Gait (0-8 points),
- Stance (0-6 points),
- **Sitting (0-4 points)**
- Speech disturbance (0-6 points)
- **Finger chase (0-4 points)**
- **Nose-finger test (0-4 points)**
- **Fast alternating hand movement (0-4 points)**
- **Heel-shin slide (0-4 points)**

For motor activities of the four extremities (items 5-8), assessments are performed bilaterally, and the mean values are used to obtain the total score.

Normally, once each of the eight categories have been assessed, the total is calculated to determine the severity of ataxia. For this study however, we will only be using five of the eight categories (which are highlighted in bold) and we will be interested in both the overall and sub-scores.

Scale for the Assessment and Rating of Ataxia (SARA)

Rater:	Date:	Participant ID:
---------------	--------------	------------------------

1.) Sitting

Proband is asked to sit on an examination bed without support of feet, eyes open and arms outstretched to the front.

0	Normal, no difficulties sitting >10 sec
1	Slight difficulties, intermittent sway
2	Constant sway, but able to sit > 10 s without support
3	Able to sit for > 10 s only with intermittent support
4	Unable to sit for >10 s without continuous support
Score:	

2.) Finger Chase

Rated separately for each side

Proband sits comfortably. If necessary, support of feet and trunk is allowed. Examiner sits in front of proband and performs 5 consecutive sudden and fast pointing movements in unpredictable directions in a frontal plane, at about 50 % of proband's reach. Movements have an amplitude of 30 cm and a frequency of 1 movement every 2 s. Proband is asked to follow the movements with his index finger, as fast and precisely as possible. Average performance of last 3 movements is rated.

0	No dysmetria
1	Dysmetria, under/ overshooting target <5 cm
2	Dysmetria, under/ overshooting target < 15 cm
3	Dysmetria, under/ overshooting target > 15 cm
4	Unable to perform 5 pointing movements
Score:	
	Left: Right:
Mean of both sides (R+L)/2:	
0	

3.) Nose-finger test

Rated separately for each side

Proband sits comfortably. If necessary, support of feet and trunk is allowed. Proband is asked to point repeatedly with his index finger from his nose to examiner's finger which is in front of the proband at about 90 % of proband's reach. Movements are performed at moderate speed. Average performance of movements is rated according to the amplitude of the kinetic tremor.

0	No tremor
1	Tremor with an amplitude < 2 cm
2	Tremor with an amplitude < 5 cm
3	Tremor with an amplitude > 5 cm
4	Unable to perform 5 pointing movements
Score:	
	Left: Right:
Mean of both sides (R+L)/2:	
0	

4.) Fast alternating hand movements

Rated separately for each side

Proband sits comfortably. If necessary, support of feet and trunk is allowed. Proband is asked to perform 10 cycles of repetitive alternation of pro- and supinations of the hand on his/her thigh as fast and as precise as possible. Movement is demonstrated by examiner at a speed of approx. 10 cycles within 7 s. Exact times for movement execution have to be taken.

0	Normal, no irregularities (performs <10s)
1	Slightly irregular (performs <10s)
2	Clearly irregular, single movements difficult to distinguish or relevant interruptions, but performs <10s
3	Very irregular, single movements difficult to distinguish or relevant interruptions, performs >10s
4	Unable to complete 10 cycles

Score:	Left:		Right:	
---------------	-------	--	--------	--

Mean of both sides (R+L)/2:	0			
------------------------------------	---	--	--	--

5.) Heel-shin slide

Rated separately for each side

Proband lies on examination bed, without sight of his legs. Proband is asked to lift one leg, point with the heel to the opposite knee, slide down along the shin to the ankle, and lay the leg back on the examination bed. The task is performed 3 times. Slide-down movements should be performed within 1 s. If proband slides down without contact to shin in all three trials, rate 4.

0	Normal
1	Slightly abnormal, contact to shin maintained
2	Clearly abnormal, goes off shin up to 3 times during 3 cycles
3	Severely abnormal, goes off shin 4 or more times during 3 cycles
4	Unable to perform the task

Score:	Left:		Right:	
---------------	-------	--	--------	--

Mean of both sides (R+L)/2:	0			
------------------------------------	---	--	--	--

Total Score /40:	0			
-------------------------	---	--	--	--

iii) Trunk impairment scale (TIS)

The Trunk Impairment Scale (TIS) is a new tool to measure motor impairment of the trunk after stroke. The TIS evaluates static and dynamic sitting balance as well as co-ordination of trunk movement.

The static subscale investigates: (1) the ability of the subject to maintain a sitting position with feet supported; (2) the ability to maintain a sitting position while the legs are passively crossed, and (3) the ability to maintain a sitting position when the subject crosses the legs actively.

The dynamic subscale contains items on lateral flexion of the trunk and unilateral lifting of the hip. To assess the coordination of the trunk, the subject is asked to rotate the upper or lower part of his or her trunk 6 times, initiating the movements either from the shoulder girdle or from the pelvic girdle, respectively. For each item, a 2-, 3- or 4-point ordinal scale is used. On the static and dynamic sitting balance and coordination subscales the maximal scores that can be attained are 7, 10 and 6 points.

The total score for TIS ranges between 0 for a minimal performance to 23 for a perfect performance.

Further information

The TIS can be viewed here: <https://youtu.be/-9tiR-V2UTM>

Trunk Impairment Scale (TIS)

The starting position for each item is the same. The patient is sitting on the edge of a bed or treatment table without back and arm support. The thighs make full contact with the bed or table, the feet are hip width apart and placed flat on the floor. The knee angle is 90°. The arms rest on the legs. If hypertonia is present the position of the hemiplegic arm is taken as the starting position. The head and trunk are in a midline position.

If the patient scores 0 on the first item, the total score for the TIS is 0.

Each item of the test can be performed three times. The highest score counts. No practice session is allowed.

The patient can be corrected between the attempts.

The tests are verbally explained to the patient and can be demonstrated if needed.

Rater:	Date:	Participant ID:	
---------------	--------------	------------------------	--

Static Sitting Balance				
Item	Scoring Criteria	Associated Score	Recorded Score	
1	Starting position	Patient falls or cannot maintain starting position for 10 seconds without arm support	0	
		Patient can maintain starting position for 10 seconds	2	
<i>*If score = 0, then TIS total score = 0</i>				
2	Starting position Therapist crosses the unaffected leg over the hemiplegic leg	Patient falls or cannot maintain sitting position for 10 seconds without arm support	0	
		Patient can maintain sitting position for 10 seconds	2	
3	Starting position Patient crosses the unaffected leg over the hemiplegic leg	Patient falls	0	
		Patient cannot cross the legs without arm support on bed or table	1	
		Patient crosses the legs but displaces the trunk more than 10 cm backwards or assists crossing with the hand	2	
		Patient crosses the legs without trunk displacement or assistance	3	
Total static sitting balance (/7):				0

Dynamic Sitting Balance				
Item	Scoring Criteria	Associated Score	Recorded Score	
1	Starting position Patient is instructed to touch the bed or table with the hemiplegic elbow (by shortening the hemiplegic side and lengthening the unaffected side) and return to the starting position.	Patient falls, needs support from an upper extremity or the elbow does not touch the bed or table	0	
		Patient moves actively without help, elbow touches bed or table	1	
<i>*If score = 0, then items 2 and 3 score 0</i>				
2	Repeat item 1	Patient demonstrates no or opposite shortening/lengthening	0	
		Patient demonstrates appropriate shortening/lengthening	1	
<i>*If score = 0, then item 3 scores 0</i>				
3	Repeat item 1	Patient compensates. Possible compensations are: (1) use of upper extremity, (2) contralateral hip abduction, (3) hip flexion (if elbow touches bed or table further than proximal half of femur), (4) knee flexion, (5) sliding of the feet.	0	
		Patient moves without compensation	1	
4	Starting position Patient is instructed to touch the bed or table with the unaffected elbow (by shortening the unaffected side and lengthening the hemiplegic side) and return to the starting position	Patient falls, needs support from an upper extremity or the elbow does not touch the bed or table	0	
		Patient moves actively without help, elbow touches bed or table	1	
<i>*If score = 0, then items 5 and 6 score 0</i>				
5	Repeat item 4	Patient demonstrates no or opposite shortening/lengthening	0	
		Patient demonstrates appropriate shortening/lengthening	1	
<i>*If score = 0, then item 6 scores 0</i>				
6	Repeat item 4	Patient compensates. Possible compensations are: (1) use of upper extremity, (2) contralateral hip abduction, (3) hip flexion (if elbow touches bed or table further than proximal half of femur), (4) knee flexion, (5) sliding of the feet.	0	
		Patient moves without compensation	1	

7	Starting position Patient is instructed to lift pelvis from bed or table at the unaffected side (by shortening the unaffected side and lengthening the hemiplegic side) and return to the starting position	Patient demonstrates no or opposite shortening/lengthening	0	
		Patient demonstrates appropriate shortening/lengthening	1	
		<i>*If score = 0, then item 8 scores 0</i>		
8	Repeat item 7	Patient compensates. Possible compensations are: (1) use of upper extremity, (2) pushing off with the ipsilateral foot (heel loses contact with the floor)	0	
		Patient moves without compensation	1	
9	Starting position Patient is instructed to lift pelvis from bed or table at the unaffected side (by shortening the unaffected side and lengthening the hemiplegic side) and return to the starting position	Patient demonstrates no or opposite shortening/lengthening	0	
		Patient demonstrates appropriate shortening/lengthening	1	
		<i>*If score = 0, then item 10 scores 0</i>		
10	Repeat item 9	Patient compensates. Possible compensations are: (1) use of upper extremities, (2) pushing off with the ipsilateral foot (heel loses contact with the floor)	0	
		Patient moves without compensation	1	
Total dynamic sitting balance: /10				0

Dynamic Sitting Balance				
Item		Scoring Criteria	Associated Score	Recorded Score
1	Starting position Patient is instructed to rotate upper trunk 6 times (every shoulder should be moved forward 3 times), first side that moves must be hemiplegic side, head should be fixated in starting position	Hemiplegic side is not moved three times	0	
		Rotation is asymmetrical	1	
		Rotation is symmetrical	2	
		<i>*If score = 0, then item 2 scores 0</i>		
2	Repeat item 1 within 6 seconds	Rotation is asymmetrical	0	
		Rotation is symmetrical	1	
3	Starting position Patient is instructed to rotate lower trunk 6 times (every knee should be moved forward 3 times), first side that moves must be hemiplegic side, upper trunk should be fixated in starting position	Hemiplegic side is not moved three times	0	
		Rotation is asymmetrical	1	
		Rotation is symmetrical	2	
		<i>*If score = 0, then item 4 scores 0</i>		
4	Repeat item 3 within 6 seconds	Rotation is asymmetrical	0	
		Rotation is symmetrical	1	
Total co-ordination /6:				0
Total Trunk Impairment Scale / 23:				0

iv) Modified Ashworth Scale (MAS)

The Modified Ashworth Scale (MAS) is used to assess spasticity which is a velocity dependent alteration in muscle tone. The patient should be resting on the bed for at least 3 minutes before beginning the test to ensure that any effort related increases in tone have subsided.

It is performed by passively moving an individual's limb first from a position of maximal possible flexion/abduction/external rotation (as appropriate) to the maximal possible opposite movement (e.g. extension/adduction/internal rotation).

Only take the limb to the point at which the first soft resistance is met. This should be done at the speed required to count "one-thousand and one".

It is important to use knowledge from the assessment of passive and active range to understand how far to move a limb to achieve maximal possible flexion or extension. If for any reason a person cannot be tested in the positions below (e.g. they are not comfortable in prone), they can be tested in a different position (e.g. supine).

Examples of the score sheets are provided for the hip, shoulder and elbow. Please make a note of the starting position on the testing proforma if it is not the standard position defined below.

Please note: Only specific movements at the joints identified below will be tested.

Starting positions

Shoulder muscles: Seated position, the head in midline and the arm alongside the trunk. The elbow should be flexed to approximately 90 degrees and forearm should be in neutral. The examiner should support the elbow and hold the wrist and move the arm to extension or external rotation (depending on the muscle being tested).

Elbow muscles: Supine or seated position, the head in midline and the arm straight alongside the trunk, forearm neutral pronation and supination if possible. With the upper arm supported on the bed, flex the elbow (testing extensors) and then fully extend the elbow (testing the flexors).

Hip muscles: Supine with legs straight out on bed with hip in neutral (midline) for abducted for adduction. External rotation can be measured in either sitting or supine. The hip is then externally rotated as required. Please note, the method for testing this movement should be informed by a brief AROM/PROM assessment/judgment.

5 (ELBOW)	Starting Positions / Joint and Movement tested / Muscle 'group' tested / Reference support			Reference
	*Most are based on the following reference:			
Joint and Movement Tested	Muscles Tested	Starting Position / Assessment Procedure		Reference
Elbow FLEXION & EXTENSION	Biceps / Triceps	Biceps: Start position: Elbow fully flexed, forearm neutral. Movement: Extend elbow from maximum possible flexion to maximum possible extension. (Triceps would be the same position, opposite direction)		https://www.elitecme.com/resource-center/rehabilitation-therapy/testing-spasticity-the-modified-ashworth-scale/
SCORING KEY ELBOW FLEXION BICEPS (RIGHT SIDE)				(LEFT SIDE)
0	No increase in tone			
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the limb is moved in flexion or extension			
2	Marked increase in tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but limb easily moved			
3	Considerable increase in tone, passive movement difficult			
4	Limb rigid in flexion or extension			
TOTAL SCORE / 4				
SCORING KEY ELBOW EXTENSION TRICEPS (RIGHT SIDE)				(LEFT SIDE)
0	No increase in tone			
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the limb is moved in flexion or extension			
2	Marked increase in tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but limb easily moved			
3	Considerable increase in tone, passive movement difficult			
4	Limb rigid in flexion or extension			
TOTAL SCORE / 4				

4 (SHOULDER)	Starting Positions / Joint and Movement tested / Muscle 'group' tested / Reference support			Reference
	*Most are based on the following reference: https://www.elitecme.com/resource-center/rehabilitation-therapy/testing-spasticity-the-modified-ashworth-scale/ Bohannon, R. et al.			
Joint and Movement Tested	Muscles Tested	Starting Position / Assessment Procedure		Reference
Shoulder EXTERNAL ROTATION & EXTENSION	Approach as muscle groups: shoulder flexors / extensors / rotators / adductors / abductors	TO FINISH Adduction: Starting Position: Supine position, the head in midline and the arm alongside the trunk. Elbow was in 90deg flexion. On the side being tested, the rater placed one hand underneath the elbow and the other hand grasped the wrist. The limb was moved into abduction (100deg).		http://web.a.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=1&sid=9a02574d-3488-4670-8921-7c3f73d53387%40dc-vv-seesmgr02
SCORING KEY EXTERNAL ROTATION IN NEUTRAL (RIGHT SIDE)				(LEFT SIDE)
0	No increase in tone			
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the limb is moved in flexion or extension			
2	Marked increase in tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but limb easily moved			
3	Considerable increase in tone, passive movement difficult			
4	Limb rigid in flexion or extension			
TOTAL SCORE / 4				
SCORING KEY EXTENSION (RIGHT SIDE)				(LEFT SIDE)
0	No increase in tone			
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the limb is moved in flexion or extension			
2	Marked increase in tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but limb easily moved			
3	Considerable increase in tone, passive movement difficult			
4	Limb rigid in flexion or extension			
TOTAL SCORE / 4				

3 (HIP)	Starting Positions / Joint and Movement tested / Muscle 'group' tested / Reference support			Reference
	*Most are based on the following reference:			
Joint and Movement Tested	Muscles Tested	Starting Position / Assessment Procedure		Reference
Hip ADDUCTION & EXTERNAL ROTATION	Adductor / Abductor groups; hamstrings / quadriceps / internal / external rotator groups	TBC / AS PER AROM / PROM CLINICAL AX		https://www.nature.com/articles/sc2009107
SCORING KEY ADDUCTION (RIGHT SIDE)				(LEFT SIDE)
0	No increase in tone			
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the limb is moved in flexion or extension			
2	Marked increase in tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but limb easily moved			
3	Considerable increase in tone, passive movement difficult			
4	Limb rigid in flexion or extension			
TOTAL SCORE / 4				
SCORING KEY EXTERNAL ROTATION IN NEUTRAL (RIGHT SIDE)				(LEFT SIDE)
0	No increase in tone			
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end range of motion when the limb is moved in flexion or extension			
2	Marked increase in tone, manifested by a catch in the middle range and resistance throughout the remainder of the range of motion, but limb easily moved			
3	Considerable increase in tone, passive movement difficult			
4	Limb rigid in flexion or extension			
TOTAL SCORE / 4				

v) Hand-Held Dynamometry (HHD)

The Hand-Held Dynamometry (HHD) testing is used to assess isometric muscle strength. There are several variations of the test and equipment with peak and average strength data as a result. For this assessment we are asking the riders to produce a 5-second maximal contraction only, not a break test. 2 trials per position to record an average of PEAK and AVERAGE scores.

It is important to use knowledge from the assessment of the rider to understand where the neutral or mid-range point occurs as to where you will measure the strength. If for any reason a person cannot be tested in the positions below (e.g. they are not comfortable in seated / supine / prone), they can be tested in a different position.

Examples of the score sheet is provided for the trunk, shoulder, hip and elbow as per the Modified Ashworth Scale (MAS) for consistency. Specific movements have been chosen for their applicability to riding, to reduce the athlete's risk of fatigue and for ethical considerations.

Starting positions

Please make a note of the starting position on the testing proforma if it is not the standard position defined below in the examples provided.

- ELBOW FLEXION AND EXTENSION

Elbow flexion and extension: See image examples.

-SHOULDER EXTENSION AND EXTERNAL ROTATION

Shoulder external rotation: Neutral position. Place the dynamometer just proximal to the styloid process of the wrist joint.

Shoulder extension: Place the dynamometer just proximal to the posterior elbow.

- TRUNK FLEXION, EXTENSION, LATERAL FLEXION, ROTATION

Trunk flexion: Place the base of dynamometer on the middle of the sternum.

Trunk rotation: Place the dynamometer on the myotendinous area of pectoralis muscle.

Trunk extension: Place the base of dynamometer at T4 spine.

Trunk lateral flexion: Place the dynamometer lateral to and against the upper thoracic wall.

- HIP ADDUCTION AND EXTERNAL ROTATION ONLY

External rotation/adduction: See image examples.

Further information

Further details of the starting positions and testing process can be found at:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5713843/>

Elbow (flexion/extension)	Shoulder (external rotation)	Shoulder (extension)
		
Trunk Lateral Side Flexion	Trunk Flexion	Trunk Extension
		
Trunk Rotation (L + R)	Hip (adduction)	Hip (external rotation)
		

		HHD ON RIGHT SIDE			HHD ON LEFT SIDE	
TRUNK SCORE (AVERAGE)						
	FLEXION	EXTENSION	LATERAL FLEXION RIGHT	ROTATION TOWARD LEFT	LATERAL FLEXION LEFT	ROTATION TOWARD RIGHT
TRIAL 1						
TRIAL 2						
AVERAGE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			AVE RIGHT	#DIV/0!	AVE LEFT	#DIV/0!
TRUNK SCORE (PEAK)						
	FLEXION	EXTENSION	LATERAL FLEXION RIGHT	ROTATION TOWARD LEFT	LATERAL FLEXION LEFT	ROTATION TOWARD RIGHT
TRIAL 1						
TRIAL 2						
AVERAGE	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
			AVE RIGHT	#DIV/0!	AVE LEFT	#DIV/0!

RIGHT HIP		EXTERNAL ROTATION		RIGHT SHOULDER		EXTENSION		RIGHT ELBOW		FLEXION	
		AVERAGE	PEAK			AVERAGE	PEAK			AVERAGE	PEAK
TRIAL 1				TRIAL 1				TRIAL 1			
TRIAL 2				TRIAL 2				TRIAL 2			
AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!
		ADDUCTION				EXTERNAL ROTATION				EXTENSION	
		AVERAGE	PEAK			AVERAGE	PEAK			AVERAGE	PEAK
TRIAL 1				TRIAL 1				TRIAL 1			
TRIAL 2				TRIAL 2				TRIAL 2			
AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!
LEFT HIP		EXTERNAL ROTATION		LEFT SHOULDER		EXTENSION		LEFT ELBOW		FLEXION	
		AVERAGE	PEAK			AVERAGE	PEAK			AVERAGE	PEAK
TRIAL 1				TRIAL 1				TRIAL 1			
TRIAL 2				TRIAL 2				TRIAL 2			
AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!
		ADDUCTION				EXTERNAL ROTATION				EXTENSION	
		AVERAGE	PEAK			AVERAGE	PEAK			AVERAGE	PEAK
TRIAL 1				TRIAL 1				TRIAL 1			
TRIAL 2				TRIAL 2				TRIAL 2			
AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!	AVERAGE		#DIV/0!	#DIV/0!
AVERAGE RIGHT		#DIV/0!		AVERAGE RIGHT		#DIV/0!		AVERAGE RIGHT		#DIV/0!	
PEAK RIGHT		#DIV/0!		PEAK RIGHT		#DIV/0!		PEAK RIGHT		#DIV/0!	
AVERAGE LEFT		#DIV/0!		AVERAGE LEFT		#DIV/0!		AVERAGE LEFT		#DIV/0!	
PEAK LEFT		#DIV/0!		PEAK LEFT		#DIV/0!		PEAK LEFT		#DIV/0!	

4) References

Bohannon, R. et al. (1987). Interrater reliability of a Modified Ashworth Scale of muscle spasticity. *Physical Therapy*, **67**, 206-207.

Craven, B., Morris, A. (2010). Modified Ashworth scale reliability for measurement of lower extremity spasticity among patients with SCI. *Spinal Cord* , **48**, 207-213.

<https://doi.org/10.1038/sc.2009.107>

Gorman, S.L., Radtka, S., Melnick, M.E., Abrams, G.M. and Byl, N.N. (2010). Development and validation of the Function In Sitting Test in adults with acute stroke. *Journal of Neurologic Physical Therapy*, **34**, 3, 150-160.

Karthikbabu, S., Chakrapani, M. (2017). Hand-Held Dynamometer is a Reliable Tool to Measure Trunk Muscle Strength in Chronic Stroke. *J Clin Diagn Res*, **11**, 9, YC09-YC12. doi:10.7860/JCDR/2017/28105.10672

Levine, P. (2018). *Stronger After Stroke*, 3rd ed. (pp. 193-198) New York, NY: Demos Medical Publishing.

Schmitz-Hübsch, T., Du Montcel, S.T., Baliko, L., Berciano, J., Boesch, S., Depondt, C., Giunti, P., Globas, C., Infante, J., Kang, J.S. and Kremer, B. (2006). Scale for the assessment and rating of ataxia: development of a new clinical scale. *Neurology*, **66**, 11, 1717-1720.

Verheyden, G., Nieuwboer, A., Mertin, J., Preger, R., Kiekens, C. and De Weerd, W. (2004). The Trunk Impairment Scale: a new tool to measure motor impairment of the trunk after stroke. *Clinical rehabilitation*, **18**, 3, 326-334.

Westrick, R.B., Duffey, M.L., Cameron, K.L., Gerber, J.P., Owens, B.D. (2013). Isometric shoulder strength reference values for physically active collegiate males and females. *Sports Health*, **5**, 1, 17-21. doi:10.1177/1941738112456280