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The intra- and inter-tester reliability of the Modified Star Excursion Balance Test with Hand Reaches

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Abstract (ENG)

Context: One of the physical factors of athletic performance is mobility. The relationship between mobility and physical performance has long been debated, but several recent studies have concluded that the reason for this dichotomy is due today isolated conventional mobility tests. Hand reaches is not a common form of mobility testing. Hand Reach Star Excursion Balance Test (HRSEBT) is a set of mobility tests that have systematically combined hand reaches in different directions. HRSEBT is known to be a valid mobility testing.

Objective: The purpose of the study is to map the inter- and intrarater reliability of these tests.

Design: Observational non-experimental study with repeated measures.

Setting: Norwegian School of Sport Sciences – Department of Physical Performance

Participants: 30 healthy male participants ($26,46 \pm 6,21$ years, height = $180,20 \pm 9.16$) were recruited.

Measurements: 20 different mobility tests were used in an upright position, 10 on each foot with only the toes on the ground on the opposite foot. HRSEBT places the test person on a mat performing reaches in different directions drawn on the mat which are based on the Star Excursion Balance Test (SEBT). Reach distance is registered in centimeters for all directions except rotation movements that were registered in degrees. All participants were tested by three different testers, resulting in the interrater reliability, while one of the testers tested the participants twice in order to establish the intrarater reliability of the particular tests.

Results: For all the 20 measures, the reliability for respectively the interrater reliability and intrarater reliability was excellent. ICC for the interrater reliability was registered to be 0.82, with 95% CI=0.78-0.93. ICC for the intrarater reliability was registered to be 0.82, with 95% CI=0.73-0.93.

Conclusion: HRSEBT is a set of tests with high reliability, both between different testers, but also repeatedly by the same tests. HRSEBT can be used safely among testers who have undergone the background of tests and the instructions of the protocol independently of their experience.

Key Words: hand-reach mobility tests, functional mobility tests, functional movement assessment

Abstract (NO)

Bakgrunn for studien: En av de fysiske faktorene som er med på å påvirke fysisk prestasjon er mobilitet. Forholdet mellom mobilitet og fysisk prestasjon har lenge vært omdiskutert, men flere nye studier har konkludert med at grunnen for denne dikotomien skyldes dagens isolerte konvensjonelle mobilitetstester. Håndutstrekning er ikke en vanlig form for mobilitetstesting. Hand Reach Star Excursion Balance Test (HRSEBT) er et sett med mobilitetstester som har systematisk kombinert håndutstrekning i ulike retninger. HRSEBT har visst til være en valid mobilitetstesting.

Hensikt: Formålet med studien er å kartlegge interater- og intrarater reliabiliteten til disse testene.

Studiedesign: Ikke-eksperimentelt observasjonsstudie med gjentatte målinger

Sted: Norges Idrettshøgskole - Seksjon for Fysisk Prestasjonsevne, Oslo

Deltagere: 30 friske mannlige forsøkspersoner ($26,46 \pm 6,21$ år, høyde = $180,20 \pm 9.16$ cm) ble rekruttert.

Metode: 20 forskjellige mobilitetstester ble brukt i stående posisjon, 10 på hver fot med kun tærne i bakken på motsatt fot. Håndutstrekningstestene plasserer forsøkspersonen på en matte der forskjellige retninger er tegnet på og tar utgangspunkt i retninger basert på Star Excursion Balance Test (SEBT). Utstrekingsdistansen er registrert i centimeter mot alle retninger utenom rotasjonsbevegelser som ble registrert i grader. Alle deltagere ble testet av tre forskjellige testere for å kartlegge interater reliabiliteten, mens en av testerne testet deltagerne enda en gang for å kartlegge intrarater reliabiliteten av testene.

Resultater: For alle 20 målinger, er reliabiliteten for henholdsvis interrater og intrarater utmerket. ICC for intrarater reliabilitet ble registrert til å være 0,82, med 95% CI = 0,78 til 0,93. ICC for interrater reliabilitet ble registrert til å være 0,82, med 95% CI = 0,73 til 0,93 for samtlige tester.

Konklusjon: HRSEBT er et sett med tester med høy reliabilitet, både mellom forskjellige testere, men også gjentatte ganger av samme tester. HRSEBT kan brukes trygd blant testere, selv med forskjellig erfaring blant dem, som har gjennomgått bakgrunnen av testene og intruksjon i protokollen

Nøkkeord: håndutstrekningstester, mobilitetstester, funksjonell mobilitetstests.

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INTRODUCTION

Background

Joint mobility is fundamental to any human movement and is one of the determining variables to physical performance. Conventional tests using goniometers are used as a measurement of mobility of individual joints in one plane of motion in one direction. These tests are commonly done in certain positions such as prone, supine or seated. Several studies done in this field have resulted in contradictory results on whether mobility, correlate with performance (McGill, Andersen, & Horne, 2012). Researchers are pointing towards a lack of integration of the kinematic chain of upright function, where there is an interdependency of mobility of different joints in all three planes of motion.

An alternative approach of assessing function that has gained popularity is dynamic postural control. Such an approach has been used in clinical and research settings evaluating function, risk of injury, deficits resulting from an injury and the effect of an intervention after injury. One set of tests frequently used is the Star Excursion Balance Test (SEBT) (Gribble, Hertel, & Plisky, 2012). One of the main ideas of SEBT is to carry out the measurements in a standing position. This makes the SEBT more functional than other conventional ROM tests obtained on a treatment table since these tests are done joint by joint, plane by plane in well-defined positions. The interdependent relationship of joints and regions are therefore diminished in such conventional tests as compared to an upright position, which maintains this property. Additionally, in standing, the gravitational force is parallel to the body's longitudinal axis, making the test more concurrent to activities of daily living.

The SEBT is a set of tests systematically combining foot reaches in different directions where dynamic postural control is based on how far the participant reaches with the foot while maintaining the base of support. Markings on the floor indicate eight different directions in 45° increments, starting from the anterior direction: anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral (for each leg). The subject stands on one leg in the center of the cross (Figure 1).

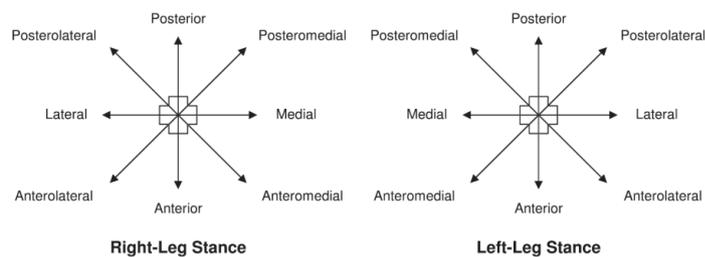


Figure 1: Overview of the SEBT reach directions (Gribble et al. 2012)

Procedure for the different reaches, as described by the authors (Gribble et al., 2012), is having the participant on the stance limb in the middle of the grid. While on standing on a single leg, the participant reaches maximally with the reaching leg in each prescribed direction. One of the criteria to get an approved trial is to lightly touch the line with the most distal portion of the reaching foot. Shifting weight or resting on the reaching foot will result in a rejected trial, which should be repeated. The participant then returns to the beginning position to a bilateral stance. According to the protocol of the SEBT, the determination of the test result is considered invalid when one or several of the following elements occur:

- the ankle of the centre placed leg is lifted above the ground,
- when the subject shifts his/hers weight on the reach foot,
- when balance is lost during retraction of the foot or
- the arm is removed from the hips.

The distance reached from the centre along one direction is measured and provides the result. The execution of the SEBT is preferably without shoes to minimize differences between subjects.

Foot reaches integrate the entire kinematic chain since they are done in a single leg stance involving in that way several joints at a time to accomplish a certain movement. SEBT is based on the work of Gray and was originally used to quantify dynamic balance or postural stability (Gray, 1995). In a wide range of clinical and research settings the SEBT has demonstrated to be an adequate tool to differentiate patients with lower extremity conditions such as ankle pathology and anterior cruciate ligament reconstructions (Gribble, Kelly, Refshauge, & Hiller, 2013).

The reliability of the SEBT has been investigated in a plethora of studies (Gribble & Hertel, 2003; Gribble et al., 2013; Hertel, Miller, & Denegar, 2000; Kinzey & Armstrong, 1998; Munro & Herrington, 2010; Plisky, Rauh, Kaminski, & Underwood, 2006; Robinson & Gribble, 2008; Shrout & Fleiss, 1979). The first (intra-tester) reliability study of the SEBT was conducted by Kinzey and Armstrong registering moderate to strong intra-class correlation coefficient (ICC) scores ranging from 0.67-0.87 (Kinzey & Armstrong, 1998). Regarding the intra-rater reliability of the SEBT, Hertel and colleagues (2000) reported similar results (ICC from 0.78 to 0.96). On the other hand, the results observed for the inter-rater were wide spread (ICC=0.35-0.93), which was due to the lower scores that occurred during the first day as a result of a learning effect.

After investigation and agreement among researchers on the optimal number of trials eliminating the learning effect, researchers have concluded that values achieved stability within the first 4 trials (Robinson & Gribble, 2008). Munro and Herrington (2010) found that reliability improved to excellent after the fourth consecutive trial (ICC=0.84-0.92). Due to poor reliability between assessors in the earlier study (Hertel et al., 2000), investigators examined those potential artefacts by improving the protocol and integrating new guidelines (Gribble et al., 2013). It was noted that the inter-rater reliability for all the 16 measures was excellent, ranging from ICC=0.86-0.92 for the normalized maximum (reach distance divided by leg length) excursion distance, and ICC=0.89-0.94 for the non-normalized measurements.

In order to evaluate results between groups, normalization is required since different persons have different leg lengths. The standard normalization procedure is correlating reach distances to lower leg length or whole body height. A study by Gribble and Hertel (2003) calculated a higher reach correlations with lower leg length than with subject's height. Anterior reach and height, and anterior reach and lower leg length were correlated with coefficients of 0.19 and 0.23, respectively ($p < 0.001$).

As mentioned earlier the principal objective of the SEBT is to evaluate human dynamic postural stability. Postural stability is defined as "*controlling the body's position in space for the dual purpose of stability and orientation*" (Shumway-Cook & Woollacott, 2011). However, there is limited documentation on the joint mobility that determines reaching distance for the different tests, especially in the frontal and transverse plane (Gribble et al., 2012). Furthermore, no rotational tests are included in the SEBT.

SEBT is a test for measuring balance and postural control. However, it does not include the mobility of upper extremities or trunk. Neither it has any rotational tests. Besides, there is limited documentation on the joint mobility that determines reaching distance for the different tests, especially in the frontal and transverse plane (Gribble et al., 2012). Therefore, the HRSEBT was developed, including hand reaches. Since we do not know if including hand reaches will alter the reliability of the SEBT, the main objective of the present study is given.

Purpose of the study

Considering the above, the purpose of the present study was to determine the inter- and intra-rater reliability of the 20 tests that compose the SEBT including hand reaches - HRSEBT and to propose guidelines for the additional rotation tests using hand reaches.

MATERIAL AND METHODS

Research design

The present study is an observational non-experimental study of inter- and intra-rater reliability

As this study is concerned with assessing inter- and intra-rater reliability, attempts were made to eliminate that any variability, as a consequence of the hand reaches (instrument) or in the performance of the participants (intra-subject) are influencing the results. This was done by using a highly standardized procedure of HRSEBT performance of the participants being examined by the same person, using the same instructions and equipment, as well as ensuring that training and scoring procedures were equal for all raters. In this study a standardized approach was used to be able to assess the upper limits of inter- and intra-rater reliability of the HRSEB tests.

Participants

A total of 30 healthy participants (all men, age = $26,46 \pm 6,21$ years, height = $180,20 \pm 9,16$) were recruited over a period of three months from three sources: 1) social media, 2) sports clubs and 3) posters and project presentation, primarily at three different universities, i.e. University College of Oslo, University of Oslo and Norwegian School of Sport Sciences.

Participants (n=30) received an information sheet about the study and gave their written informed consent (see Appendix 2). The study was approved by the Regional Ethics Committee.

Protocol

Before the test sessions at the human movement laboratory of the Norwegian School of Sport Sciences, an investigator with many years of experience with the particular test battery and one of the developers of HRSEBT instructed the other two raters at the test site using a script and a standardized demonstration. Furthermore, the two testers attended a practical course consisting of 20 hours which took place in Oslo-

Norway organized by 1080Motion (1080Motion AB, Stockholm, Sweden). This was to make the raters certified practitioners and ensure that they were properly instructed and could carry out the measures independently. On testing days, 3 raters (the supervising investigator and the two trained raters) each assessed the HRSEBT performance of each participant.

Anthropometry

The age of all the tests subjects was registered at the beginning of the test protocol. Other measurements included leg length, arm length and wingspan and were measured with a tape measure (TR-Tailors tape, Ohio, USA). Body height was measured using a stadiometer (Seca 217, NY, USA).

The test battery is based on 24 different tests that are measured in centimeters or in degrees on a specially designed grid (1080 motion, Stockholm, Sweden) (Figure 1). A plumb weight (Industrial Corp., Punjab,India) was used for the above the head tests 10 out of 24, while a 90cm rod was used for the rotational tests 4 out of 24 (see Table 1). During the remaining 10 tests, the participant was reaching as far as possible along the vector on the HRSEBT Grid.

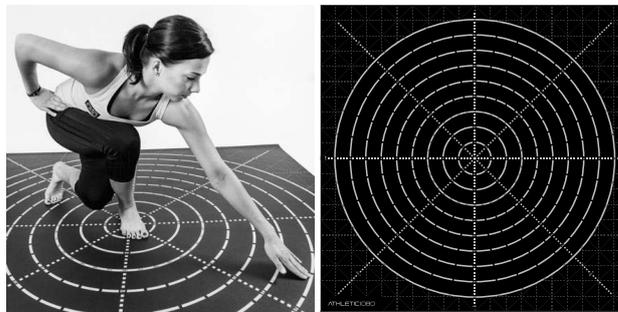


Figure 2: HRSEBT Grid (1080 Motion, Stockholm, Sweden) that was used during the test procedure of the tests (with permission)

Table 1: Oral instructions for the reaching tests with tapping on the mat

1. "Keep your stance foot flat on the floor, in the middle of the the first circle on the mat point straight forward with your non-reaching hands on your hips."
2. "Keep your balance foot as dictated by the test towards the direction you are going to perform the hand reach. "
3. "Make a reach with the hand dictated by the test as far as possible and make a light tap on the measuring tape without by any means supporting your body on the mat."
4. "Without pushing off the ground with your reaching hand, return back to the center of the testing mat"
5. "You may apply any movement pattern you desire to reach as far as possible as long as you maintain the stance foot in the middle of the first circle of the mat, your balance foot on your toes pointing towards the direction you are reaching and the hand dictated by the test on the hip."

Table 1: Oral instruction for the rotational tests where a 90cm rod was used.

6. "Keep your arms and knees streight without bending during any part of the movement with both the stance and balance foot pointing streight forward."
7. "Rotate your whole body using your arms as a pinpoint, with the one hand above the other so that the long finger of the one hand attaches the long one of the other hand, as far possible towards the side the tests dictates"
8. "Return then back to your starting position"

Table 2: Oral instruction for the overhead tests where a plumb weight was used.

9. "Keep your reaching arm streight during the whole movement, icluding the reaching and the return back to the starting position."
10. "Have the stance foot always on the first circle in the middle of the mat with the foot poiting straight forward, while the balance foot points opposite of the direction you are reaching"
11. "Return then back to your starting position"

Participants performed the HRSEBT by having the stance foot in the middle of the first circle of the mat. The toes of the stance foot extended beyond the first circle anteriorly as the heel posteriorly. The balance foot was described as a “toe touch” and was placed at 15cm away for the middle point of the mat. Then the participant was reaching with hand as far as possible along the different grid lines, while having the opposite arm on the hip, and then returning to the starting position; touch lightly on the grip mat with the most distal portion of the reaching hand, without falling, lifting the stance foot of the ground or having the heel of the balance foot on the ground; and return the reaching hand to the start position at the apex of the grid, resuming a stable starting position.

The goal was to have the individual establish a stable base of support on the stance limb at the apex of the testing grid and a toe touch on the balance foot in order to maintain support through a maximal reach excursion in multiple directions.

Participants performed all the tests standing barefoot. Standardized oral instructions were given to every participant (Table 1-3).

A trial was considered incomplete if the participant touched the grip mat or came to rest at the touchdown point by resting the balance foot on the ground. Neither was the trial considered if the participant lifted the heel of the stance foot off the ground.

HRSEBT consists of 8 directions, 3 out of 8 composing the anterior aspect: A0, R45 and L45 (A=anterior, R=right, L=left); 3 out of 8 composing the posterior aspect: P180, R135 and L135 (P=posterior); and the remaining to composing the lateral aspect: L90 and R90 (L=lateral) and horizontal aspect: Left and Right Rotation (H=Horizontal).

For all the aspects the stance foot pointed straight forward. For the balance foot the following guidelines were established: for the anterior aspect the balance foot points towards the direction the participants is reaching. For the posterior aspect the balance foot points opposite the direction the participant is reaching, and for the rotational tests both feet point towards straight forward, one in stance and one in toe-touch.

Before each measurement, participants were allowed to perform 3 practice trials.

Consequently, participants were allowed resting for a couple of minutes between the practice and the test trials.

Table 3: Categorization of the tests (in numbers) based on the 9 directions mentioned earlier.

TEST CATEGORIZATION			
Anterior Tests	Posterior Tests	Lateral Tests	Horizontal Tests
A0: 3, 4	P180: 13, 14	L90: 7, 10	RR: 18, 20
R45: 1, 6	P135: 12, 15	R90: 8, 9	LR: 17, 19
L45: 2, 5	L135: 11, 16		

A=anterior, R=right, L=left, P=posterior, RR=right rotation, LR=left rotation

Data Collection

Three trials were executed and registered of which the highest value was used for statistical analysis. All participants were tested in total 3 times on different days during the testing period.

Rater 1 and 2 tested all the participants once, while rater 3 tested them twice (Table 5). Inter-rater reliability was registered comparing the results from rater 1, 2 and 3.

Intra-rater reliability on the other hand was registered by comparing the results from rater 3 on two different days. At least 5 days between test sessions was allowed.

The order of testing was randomized using the randomization function in Microsoft® Excel® (Microsoft Corporation, USA). All participants were registered with a number in a spread sheet. Each tester kept the recorded results in its own private computer. By the end of the period a third party gathered all the data from all the raters and registered them in a common document. This was done to keep the raters blinded as to how participants performed when they were tested by the other raters.

Table 4: Description of each movement of the HRSEBT.

Functional Movement Patterns – Description of movement		
Test nr.*	Combined Planes	Description
1	L SLS L arm R45 reach to floor	Left leg standing, left arm is reaching as far as possible along the R45 vector on the floor.
2	R SLS R arm L45 reach to floor	Right leg standing, right arm is reaching as far as possible along the L45 vector on the floor.
3	L SLS B arms A0 reach to floor	Left leg standing, both arms reaching as far as possible along the A0 vector on the floor.
4	R SLS B arms A0 reach to floor	Right leg standing, both arms reaching as far as possible along the A0 vector on the floor.
5	L SLS R arm L45 reach to floor	Left leg standing, right arm is reaching as far as possible along the L45 vector on the floor.
6	R SLS L arm R45 reach to floor	Right leg standing, left arm is reaching as far as possible along the R45 vector on the floor.
7	L SLS B arms L90 overhead reach	Left leg standing, both arms reaching as far to the side as possible along the L90 vector, above the head.
8	R SLS B arms R90 overhead reach	Right leg standing, both arms reaching as far to the side as possible along the R90 vector, above the head.
Single Planes		
9	L SLS B arms R90 overhead reach	Left leg standing, both arms reaching as far to the side as possible along the R90 vector, above the head.
10	R SLS B arms L90 overhead reach	Right leg standing, both arms reaching as far to the side as possible along the L90 vector, above the head.
11	L SLS R arm L135 overhead reach	Left leg standing, right arm is reaching as far back as possible along the L135 vector, above the head.
12	R SLS L arms R135 overhead reach	Right leg standing, left arm is reaching as far back as possible along the R135 vector, above the head.
13	L SLS B arms P180 overhead reach	Left leg standing, both arms reaching as far back as possible along the P180 vector, above the head.
14	R SLS B arms P180 overhead reach	Right leg standing, both arms reaching as far back as possible along the P180 vector, above the head.
15	L SLS L arm R135 overhead reach	Left leg standing, left arm is reaching as far back as possible along the R135 vector, above the head.
16	R SLS R arm L135 overhead reach	Right leg standing, right arm is reaching as far back as possible along the L135 vector, above the head.
17	L SLS B arms R rotational reach at shoulder height	Left leg standing, both arms at shoulder height: rotation as far to the right as possible.
18	R SLS B arms L rotational reach at shoulder height	Right leg standing, both arms at shoulder height: rotation as far to the left as possible.
19	L SLS B arms L rotational reach at shoulder height	Left leg standing, both arms at shoulder height: rotation as far to the left as possible.
20	R SLS B arms R rotational reach at shoulder height	Right leg standing, both arms at shoulder height: rotation as far to the right as possible.

*Each test is labeled as their respective test number throughout this thesis. For a full description of the tests, please see Appendix 1.

(SLS=single leg stance, L=left, R=right, B=both)

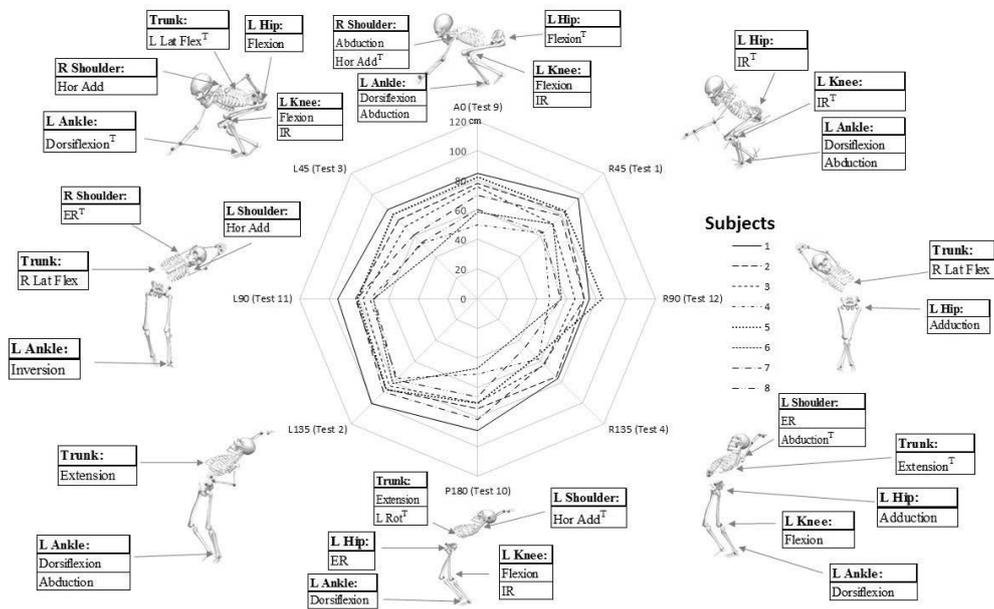


Figure 3: Illustration of the tests performed on the left foot for the joint angles that correlated significantly. The center diagram shows the average maximum reach distance for each subject and the skeletons visualize the subjects' postures in each reaching task. For a detailed description of each test, please see Appendix 1. (adapted from Eriksrud et al, 2013).

STATISTICAL METHODS

Interrater and intrarater reliability

In statistics intra-rater reliability is the degree of agreement among repeated administrations of a diagnostic test performed by a single rater.

Intra- and inter-rater reliability was calculated through Intra-class correlation coefficients (ICC) using SPSS v22 (IBM Corp...). Coefficients of variations (CV) were used to assess the reliability of the individual items of the HRSEBT. Level of significance was set at 95% ($p < 0.05$). The interpretation of the ICC was done as follows: poor (> 0.4), fair to good (0.4-0.75) and excellent (> 0.75) (Fleiss, 1999).

Table 6: Values used as a reference for interpretation of the Intra-class Correlation Coefficient

Intra-class Correlation Coefficient: Interpretation Values	
Strength of Agreement	Agreement Value
Excellent	> 0.75
Fair - Good	0.4-0.75
Poor	< 0.4

Ethical Aspects of the Project

The subjects were provided with information about the risks and commitments of participating in the study, in accordance with the Helsinki declaration. This includes a sheet (see Appendix 2) giving an overview of the background and significance of the study and possible advantages and risks with the test protocol. In addition, they were informed of the details regarding data collection such as the guarantee to anonymity and secrecy of personal information.

RESULTS

Inter-rater Reliability

Table 7: Statistical results of the interrater reliability with ICC, 95% confidence intervals and CV

Tests	Intraclass Correlation ^b ICC ^b		95% Confidence Intervals		CV ^d (mean)
			Lower Bound	Upper Bound	
Test 1: Left leg, left hand. R45	Single Measures	.865 ^a	.769	.929	.0301
	Average Measures	.951 ^c	.909	.975	
Test 2: Right leg, right hand. L45	Single Measures	.860 ^a	.760	.926	.0299
	Average Measures	.948 ^c	.905	.974	
Test 3: Left leg, b hands. A0	Single Measures	.921 ^a	.858	.960	.0274
	Average Measures	.972 ^c	.948	.986	
Test 4: Right leg, bilat hands. A0	Single Measures	.912 ^a	.844	.955	.0282
	Average Measures	.969 ^c	.942	.984	
Test 5: Left Leg, right hand. L45	Single Measures	.878 ^a	.789	.936	.0430
	Average Measures	.956 ^c	.918	.978	
Test 6: Right leg, left hand. R45	Single Measures	.859 ^a	.760	.926	.0450
	Average Measures	.948 ^c	.905	.974	
Test 7: Left leg, b hands. L90	Single Measures	.593 ^a	.378	.767	.0824
	Average Measures	.814 ^c	.646	.908	
Test 8: Right leg, b hands. R90	Single Measures	.815 ^a	.682	.903	.0578
	Average Measures	.930 ^c	.866	.965	
Test 9: Left leg, b hands. R90	Single Measures	.861 ^a	.762	.927	.0527
	Average Measures	.949 ^c	.906	.974	
Test 10: Right leg, b hands. L90	Single Measures	.878 ^a	.788	.936	.0509
	Average Measures	.956 ^c	.918	.978	
Test 11: Left leg, right hand. L135	Single Measures	.840 ^a	.727	.915	.0518
	Average Measures	.940 ^c	.889	.970	
Test 12: Right leg, left hand. R135	Single Measures	.865 ^a	.768	.929	.0524
	Average Measures	.951 ^c	.909	.975	
Test 13: Left leg, b hands. P180	Single Measures	.870 ^a	.777	.932	.0544
	Average Measures	.953 ^c	.913	.976	
Test 14: Right leg, b hands. P180	Single Measures	.835 ^a	.721	.912	.0609
	Average Measures	.938 ^c	.886	.969	
Test 15: Left leg, left hand. R135	Single Measures	.764 ^a	.615	.871	.1254
	Average Measures	.906 ^c	.828	.953	
Test 16: Right leg, right hand. L135	Single Measures	.769 ^a	.608	.877	.1279
	Average Measures	.909 ^c	.823	.955	
Test 17: Left leg, Right rotation	Single Measures	.784 ^a	.644	.883	.0428
	Average Measures	.916 ^c	.845	.958	
Test 18: Right leg, left rotation	Single Measures	.712 ^a	.526	.844	.0481
	Average Measures	.881 ^c	.769	.942	
Test 19: Left leg, Left rotation	Single Measures	.789 ^a	.647	.886	.0514
	Average Measures	.918 ^c	.846	.959	
Test 20: Right leg, right rotation	Single Measures	.822 ^a	.698	.905	.0507
	Average Measures	.933 ^c	.874	.966	

Two-way mixed effects model where people effects are random and measures effects are fixed.

- a. The estimator is the same, whether the interaction effect is present or not.
- b. Type A intraclass correlation coefficients using an absolute agreement definition.
- c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.
- d. Coefficient of Variation (CV) illustrates the ratio of the standard deviation σ to the mean μ

ICC from **Test 1: Left leg, left hand, R45 is 0.865**, with 95% confidence interval (CI) of 0.769 and 0.929. Single average measures, where individual values are collected, of ICC=0.865 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0301 (3%).

ICC from **Test 2: Right leg, right hand, L45 is 0.860**, with 95% CI of 0.760 and 0.926. Single average measures of ICC=0.860 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0299 (2,9%).

ICC from **Test 3: Left leg, b hands, A0 is 0.921**, with 95% CI of 0.858 and 0.960. Single average measures of ICC=0.921 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0274 (2,7%).

ICC from **Test 4: Right leg, bilat hands, A0 is 0.912**, with 95% CI of 0.844 and 0.955. Single average measures of ICC=0.912 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0282 (2.8%).

ICC from **Test 5: Left Leg, right hand, L45 is 0.878**, with 95% CI of 0.789 and 0.936. Single average measures of ICC=0.878 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0430 (4.3).

ICC from **Test 6: Right leg, left hand, R45 is 0.859**, with 95% CI of 0.760 and 0.926. Single average measures of ICC=0.859 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0450 (4.5%).

ICC from **Test 7: Left leg, b hands, L90 is 0.593**, with 95% CI of 0.178 and 0.767. Single average measures of ICC=0.593 gives evidence to support a fair to good agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0824 (8.2%).

ICC from **Test 8: Right leg, b hands, R90 is 0.815**, with 95% CI of 0.682 and 0.903. Single average measures of ICC=0.815 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0578 (5.8%).

ICC from **Test 9: Left leg, b hands, R90 is 0.861**, with 95% CI of 0.762 and 0.927. Single average measures of ICC=0.861 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0527 (5.3%).

ICC from **Test 10: Right leg, b hands, L90 is 0.878**, with 95% CI of 0.788 and 0.936. Single average measures of ICC=0.878 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0509 (5.1%).

ICC from **Test 11: Left leg, right hand, L135 is 0.840**, with 95% CI of 0.727 and 0.915. Single average measures of ICC=0.840 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0518 (5.2%).

ICC from **Test 12: Right leg, left hand, R135 is 0.865**, with 95% CI of 0.768 and 0.929. Single average measures of ICC=0.865 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0524 (5.2%).

ICC from **Test 13: Left leg, b hands, P180 is 0.870**, with 95% CI of 0.777 and 0.932. Single average measures of ICC=0.870 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0544 (5.4%).

ICC from **Test 14: Right leg, b hands, P180 is 0.835**, with 95% CI of 0.721 and 0.912. Single average measures of ICC=0.835 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0609 (6.1%).

ICC from **Test 15: Left leg, left hand, R135 is 0.764**, with 95% CI of 0.615 and 0.871. Single average measures of ICC=0.764 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .1254 (12.5%).

ICC from **Test 16: Right leg, right hand, L135 is 0.769**, with 95% CI of 0.608 and 0.877. Single average measures of ICC=0.769 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .1279 (12.8%).

ICC from **Test 17: Left leg, Right rotation is 0.784**, with 95% CI of 0.644 and 0.883. Single average measures of ICC=0.784 gives evidence to support excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0428 (4.3%).

ICC from **Test 18: Right leg, left rotation is 0.712**, with 95% CI of 0.526 and 0.844. Single average measures of ICC=0.712 gives evidence to support a fair to good agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0481 (4.8%).

ICC from **Test 19: Left leg, Left rotation is 0.789**, with 95% CI of 0.647 and 0.886. Single average measures of ICC=0.789 gives evidence to support excellent agreement among the three raters for the particular test. .0514 (5.1%).

ICC from **Test 20: Right leg, right rotation is 0.822**, with 95% CI of 0.698 and 0.905. Single average measures of ICC=0.822 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0507 (5.1%).

Table 8: Average values for each one of the sub categories (table 4) of the HRSEBT.

Anterior Inter	Posterior Inter	Lateral Inter	Horizontal Inter
Test 1 0.86	Test 11 0.84	Test 7 0.59	Test 17 0.78
Test 2 0.86	Test 12 0.86	Test 8 0.81	Test 18 0.71
Test 3 0.92	Test 13 0.87	Test 9 0.86	Test 19 0.78
Test 4 0.91	Test 14 0.83	Test 10 0.87	Test 20 0.82
Test 5 0.87	Test 15 0.76		
Test 6 0.85	Test 16 0.76		
Mean	Mean	Mean	Mean
0.88	0.82	0.78	0.77
Range 0.79-0.93	Range 0.70-0.90	Range 0.65-0.88	Range 0.62-0.87

Mean values for each of the sub categories for the interrater reliability have resulted in an average ICC=0.88 with 95% CI=0.79-0.93 for the Anterior Tests. Slightly lower average values of the ICC=0.82 with 95% CI=0.70-0.90 are registered for the Posterior Tests, while values of ICC=0.78 with 95% CI=0.65-0.88 and ICC=0.77 with 95% CI=0.62-0.87 have been registered for respectively the Lateral and the Horizontal Tests.

Intra-rater Reliability

Table 9: Statistical results of the intra-rater reliability with ICC, 95% confidence intervals and coefficient of variation (CV)

Tests	Intraclass Correlation ^b		95% Confidence Intervals		CV ^d (mean)
	ICC ^b		Lower Bound	Upper Bound	
Test 1: Left leg, left hand. R45	Single Measures	.763 ^a	.562	.879	.0296
	Average Measures	.866 ^c	.719	.936	
Test 2: Right leg, right hand. L45	Single Measures	.843 ^a	.689	.924	.0260
	Average Measures	.915 ^c	.816	.961	
Test 3: Left leg, b hands. A0	Single Measures	.952 ^a	.901	.977	.0183
	Average Measures	.975 ^c	.948	.988	
Test 4: Right leg, bilat hands. A0	Single Measures	.891 ^a	.782	.947	.0236
	Average Measures	.942 ^c	.877	.973	
Test 5: Left Leg, right hand. L45	Single Measures	.937 ^a	.869	.970	.0579
	Average Measures	.967 ^c	.930	.985	
Test 6: Right leg, left hand. R45	Single Measures	.918 ^a	.834	.961	.0313
	Average Measures	.957 ^c	.909	.980	
Test 7: Left leg, b hands. L90	Single Measures	.414 ^a	.073	.671	.0812
	Average Measures	.585 ^c	.136	.803	
Test 8: Right leg, b hands. R90	Single Measures	.783 ^a	.589	.892	.0539
	Average Measures	.879 ^c	.741	.943	
Test 9: Left leg, b hands. R90	Single Measures	.792 ^a	.602	.897	.0580
	Average Measures	.884 ^c	.752	.946	
Test 10: Right leg, b hands. L90	Single Measures	.871 ^a	.743	.937	.0424
	Average Measures	.931 ^c	.852	.968	
Test 11: Left leg, right hand. L135	Single Measures	.869 ^a	.741	.936	.0431
	Average Measures	.930 ^c	.851	.967	
Test 12: Right leg, left hand. R135	Single Measures	.879 ^a	.761	.941	.0524
	Average Measures	.936 ^c	.864	.970	
Test 13: Left leg, b hands. P180	Single Measures	.876 ^a	.754	.939	.0511
	Average Measures	.934 ^c	.860	.969	
Test 14: Right leg, b hands. P180	Single Measures	.823 ^a	.657	.913	.0540
	Average Measures	.903 ^c	.793	.954	
Test 15: Left leg, left hand. R135	Single Measures	.776 ^a	.556	.891	.1011
	Average Measures	.874 ^c	.715	.942	
Test 16: Right leg, right hand. L135	Single Measures	.841 ^a	.632	.928	.1107
	Average Measures	.914 ^c	.774	.963	
Test 17: Left leg, Right rotation	Single Measures	.867 ^a	.738	.935	.0318
	Average Measures	.929 ^c	.849	.966	
Test 18: Right leg, left rotation	Single Measures	.832 ^a	.674	.917	.0337
	Average Measures	.908 ^c	.805	.957	
Test 19: Left leg, Left rotation	Single Measures	.822 ^a	.659	.912	.0381
	Average Measures	.903 ^c	.794	.954	
Test 20: Right leg, right rotation	Single Measures	.813 ^a	.637	.908	.0448
	Average Measures	.897 ^c	.778	.952	

Two-way mixed effects model where people effects are random and measures effects are fixed.

- a. The estimator is the same, whether the interaction effect is present or not.
- b. Type A intra-class correlation coefficients using an absolute agreement definition.
- c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.
- d. Coefficient of Variation (CV) illustrates the ratio of the standard deviation σ to the mean μ

ICC from **Test 1: Left leg, left hand, R45 is 0.763**, with 95% confidence interval (CI) of 0.562 and 0.879. Single average measures, where individual values are collected, of ICC=0.763 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0296 (3%).

ICC from **Test 2: Right leg, right hand, L45 is 0.843**, with 95% CI of 0.689 and 0.924. Single average measures of ICC=0.843 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0260 (2.6%).

ICC from **Test 3: Left leg, b hands, A0 is 0.952**, with 95% CI of 0.901 and 0.977. Single average measures of ICC=0.952 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0183 (1.8%).

ICC from **Test 4: Right leg, bilat hands, A0 is 0.891**, with 95% CI of 0.782 and 0.947. Single average measures of ICC=0.891 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0236 (2.4%).

ICC from **Test 5: Left Leg, right hand, L45 is 0.937**, with 95% CI of 0.869 and 0.970. Single average measures of ICC=0.937 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0579 (5.8%).

ICC from **Test 6: Right leg, left hand, R45 is 0.918**, with 95% CI of 0.834 and 0.961. Single average measures of ICC=0.918 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0330 (3.3%).

ICC from **Test 7: Left leg, b hands, L90 is 0.414**, with 95% CI of 0.073 and 0.671. Single average measures of ICC=0.414, being the lowest value registered, gives evidence to support a fair to good agreement among the three raters for the particular test. CI gives values from poor up to fair to good reliability. Coefficient of Variation (CV) was estimated to be .0812 (8.1%).

ICC from **Test 8: Right leg, b hands, R90 is 0.783**, with 95% CI of 0.589 and 0.892. Single average measures of ICC=0.783 gives evidence to support excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0539 (5.4%).

ICC from **Test 9: Left leg, b hands, R90 is 0.792**, with 95% CI of 0.602 and 0.897. Single average measures of ICC=0.792 gives evidence to support excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0580 (5.8%).

ICC from **Test 10: Right leg, b hands, L90 is 0.871**, with 95% CI of 0.743 and 0.937. Single average measures of ICC=0.871 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0424 (4.2%).

ICC from **Test 11: Left leg, right hand, L135 is 0.869**, with 95% CI of 0.741 and 0.936. Single average measures of ICC=0.869 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0411 (4.1%).

ICC from **Test 12: Right leg, left hand, R135 is 0.879**, with 95% CI of 0.761 and 0.941. Single average measures of ICC=0.879 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0424 (4.2%).

ICC from **Test 13: Left leg, b hands, P180 is 0.876**, with 95% CI of 0.754 and 0.939. Single average measures of ICC=0.876 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0511 (5.1%).

ICC from **Test 14: Right leg, b hands, P180 is 0.823**, with 95% CI of 0.657 and 0.913. Single average measures of ICC=0.823 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0540 (5.4%).

ICC from **Test 15: Left leg, left hand, R135 is 0.776**, with 95% CI of 0.556 and 0.891. Single average measures of ICC=0.776 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .1011 (10.1%).

ICC from **Test 16: Right leg, right hand, L135 is 0.841**, with 95% CI of 0.632 and 0.928. Single average measures of ICC=0.841 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .1107 (11.1%).

ICC from **Test 17: Left leg, Right rotation is 0.867**, with 95% CI of 0.738 and 0.935. Single average measures of ICC=0.867 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0318 (3.1).

ICC from **Test 18: Right leg, left rotation is 0.832**, with 95% CI of 0.674 and 0.917. Single average measures of ICC=0.832 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0337 (3.4%).

ICC from **Test 19: Left leg, Left rotation is 0.822**, with 95% CI of 0.659 and 0.912. Single average measures of ICC=0.822 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0381 (3.8%).

ICC from **Test 20: Right leg, right rotation is 0.813**, with 95% CI of 0.637 and 0.908. Single average measures of ICC=0.813 gives evidence to support an excellent agreement among the three raters for the particular test. Coefficient of Variation (CV) was estimated to be .0448 (4.5%).

Table 10: Mean values for each one of the sub categories (table 4) of the HRSEBT.

Anterior Inter	Posterior Inter	Lateral Inter	Horizontal Inter
Test 1 0,76	Test 11 0,86	Test 7 0,41	Test 17 0,86
Test 2 0,84	Test 12 0,87	Test 8 0,78	Test 18 0,83
Test 3 0,95	Test 13 0,87	Test 9 0,79	Test 19 0,82
Test 4 0,89	Test 14 0,82	Test 10 0,87	Test 20 0,81
Test 5 0,93	Test 15 0,77		
Test 6 0,91	Test 16 0,84		
Mean	Mean	Mean	Mean
0.88	0.84	0.71	0.84
Range 0.77-0.94	Range 0.78-0.92	Range 0.50-0.84	Range 0.67-0.91

Mean values for each of the sub categories for the intrarater reliability have resulted in an average ICC=0.88 with 95% CI=0.77-0.94 for the Anterior Tests. Slightly lower average values of the ICC=0.84 with 95% CI=0.78-0.92 are registered for the Posterior Tests, while values of ICC=0.71 with 95% CI=0.50-0.84 and ICC=0.84 with 95% CI=0.67-0.91 have been registered for respectively the Lateral and the Horizontal Tests.

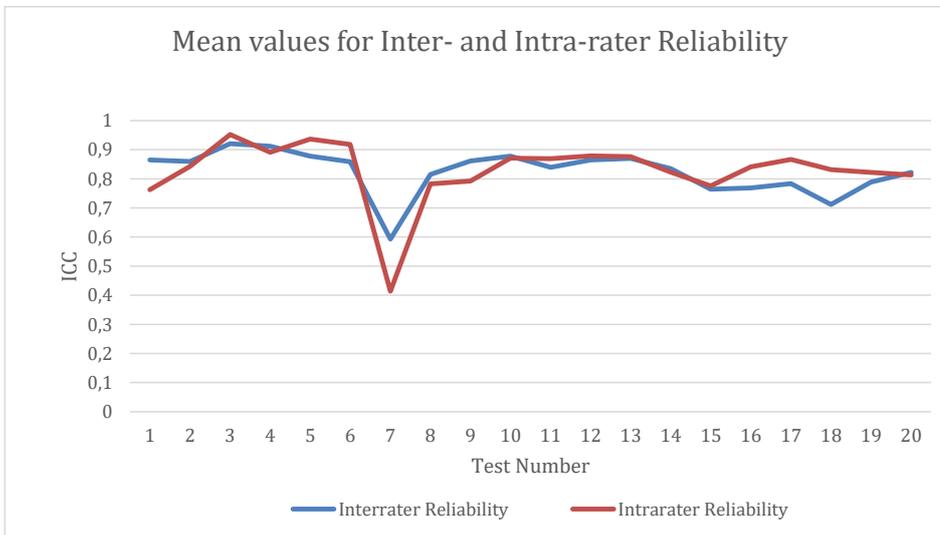


Figure 4: Mean values of all tests for Inter- and Intra-rater reliability of the HRSEBT

Figure 4 illustrates the mean values of all the tests from 1-20 resulting in an overall ICC=0.82 (95% CI=0.78-0.93) for the inter-rater reliability and ICC=0.82 (95% CI=0.73-0.93) for the intra-rater reliability of HRSEBT. Based on the registered results as seen in the figure 4, there is a particular pattern regarding both the intrarater and interrater reliability of the tests. Reliability of the Test 7: Left leg, b hands, L90 has been registered to be fair to good in both cases (ICC_{Inter}=0.59, ICC_{Intra}=0.41), with the intrarater reliability being the lowest value registered, with a quite wide CI varying from the lowest value being poor and the highest value corresponding to good reliability. On the other hand, the reliability of the Test 15: Left leg, left hand, R135 was registered in both cases to be fair to good (ICC_{Inter}=0.76, ICC_{Intra}=0.77) with similar CI in both cases. While Test 18 were registered to have a fair to good interrater reliability (ICC=0.71), this particular test had excellent intrarater reliability (ICC=0.83).

Table 11: Comparison of the 20 tests grouped based on their inter- or intrarater reliability.

Inter- and Intrarater reliability - Comparison					
Fair to good – Wide CI		Fair to good		Excellent	
Interrater	Intrarater	Interrater	Intrarater	Interrater	Intrarater
Test 7	Test 7			Test 1	Test 1
				Test 2	Test 2
				Test 3	Test 3
				Test 4	Test 4
				Test 5	Test 5
				Test 6	Test 6
				Test 8	Test 8
				Test 9	Test 9
				Test 10	Test 10
				Test 11	Test 11
				Test 12	Test 12
				Test 13	Test 13
				Test 14	Test 14
				Test 15	Test 15
				Test 16	Test 16
				Test 17	Test 17
				Test 18	Test 18
				Test 19	Test 19
				Test 20	Test 20

DISCUSSION

RELIABILITY

This is the first study to investigate the interrater and intrarater reliability of the 20 tests that compose HRSEBT and to include guidelines for the addition of rotational tests using hand reaches.

Assessment of mobility with the HRSEBT had excellent interrater reliability, as per the classification of Fleiss (Fleiss, 1999). As illustrated in figure 4, the overall reliability for respectively interrater and intrarater is excellent ($ICC_{Inter}=0.82$ & 95% CI=0.78-0.93, $ICC_{Intra}=0.82$ & 95% CI=0.73-0.93). For each type of measure (average and maximum), our results demonstrate excellent consistency of measurements by multiple investigators for 17/20 tests regarding the interrater reliability (table 7 & 8) and 18/20 for the intrarater reliability (table 9 & 10). An overview of all the tests grouped based on respectively inter- and intrarater reliability is found illustrated (table 11). As for the remaining, fair to good reliability with relatively wide CI was found for 1/20 tests and fair to good with relatively narrow CI was found for 2/20 tests (table 11).

This information adds to the body of knowledge regarding the usefulness of the HRSEBT as an assessment tool for mobility in the field and research practice. Establishing excellent interrater reliability among 3 raters and intrarater reliability during to different days supports the use of the HRSEBT, especially among both experienced and non-experienced raters. The number of raters in this study are in line with the number of raters in the study of interrater reliability of the SEBT conducted by Griddle and colleagues (Gribble et al., 2013). Their study was the first in which more than 2 raters evaluated the interrater reliability of the SEBT. Experience varied among the investigators, but each rater was trained by the same SEBT expert before testing as it was performed in our study. Despite the varied experience of the investigators in our study, the interrater reliability of the HRSEBT was excellent ($ICC=0.82$, 95% CI=0.71 – 0.91) and in line with that of the study of the SEBT (Gribble et al., 2013), where they reported $ICC=0.86$ with 95% CI (0.77 – 0.93). This allows us to conclude that the HRSEBT can be used with confidence across raters of different experience levels.

INTERRATER RELIABILITY

The average value for the interrater reliability slightly falls from the anterior tests to the posterior, lateral and the horizontal tests (table 8). It is important to notice that the anterior tests are the only tests where the mobility is registered when the participant had direct contact between finger and mat. However, during the posterior and the lateral tests, a plumb weight was used to measure the result on the mat. Furthermore, during the horizontal tests, a 90cm rod was used to measure the distance the participant reaches on the mat. Such lower estimates of reliability seem to be correlated with the use the extra equipment (plumb and rod), which may have resulted in additional error of measurement.

Interater reliability for the anterior tests has been calculated to be 0.88 with 95% CI (0.79-0.93), resulting in an excellent agreement among raters. As mentioned earlier, these particular tests, require the participant to have direct contact with the mat; as during all the tests of the SEBT where measurement is registered when the participant touches the mat with the foot. The results here seem to be even closer with that of the reliability study of SEBT (Gribble et al., 2013) that reported similar results (0.88, 95% CI 0.80-0.94). Furthermore, the interater reliability of the posterior tests has been calculated to be 0.82 with a 95% CI (0.70-0.90), which is slightly lower that the results from the anterior tests. During those tests, and the consequent, a plumb seems to give some error of measurement. This can be due to the fact that during the measurement, the rater has to hold and adjust the rope attached to the plumb according to how far the participant reaches in the corresponding direction. At the same time the rater has to observe the quality of the movement of the participant that is based on the instructive guidelines, which can make it challenging to perfectly adjust the projection of the rope with the plumb on the mat. Such rope movements result in pendulum moments of the plumb that can project further away on the mat than the exact point where the participant actually reached.

The same principle applies to the interater reliability of the lateral tests being in average 0.78 with 95% CI (0.65-0.88) resulting in similar pattern and, slightly, lower values than the posterior tests. Even though the average value results in a strong agreement among the three raters, the CI seems to be quite wide. Last, the interater reliability of

the horizontal tests has been calculated to be 0.78 with 95% CI (0.62-0.87), resulting in a as wide CI as the lateral tests. During the horizontal tests a rod was used which, compared to the plumb weight, does not have any pendulum, but the measurement of the reaching distance of the participant can be projected cm away if only a small movement of the proximal part of the rope happens.

INTRARATER RELIABILITY

As it has been mentioned earlier, the results indicate a high agreement among raters between inter- and intrarater reliability (table 11). Regardless the level of reliability, namely fair to good with wide CI, good or excellent, a similar has been registered on the interrater reliability as it has been on the intrarater reliability. An overall intrarater reliability for each of the subgroups (table 10) has been calculated followed with a graphical illustration (figure 4) resulting in a certain pattern regarding the subgroups of the HRSEBT, but varying of that of the interater reliability regarding the Lateral and the Horizontal Tests. All in all, the pattern of the different subgroups of the HRSEBT, would support the thinking process around the use of the equipment and the error of measurement to which that this may result. Despite an average ICC=0.83 for the Horizontal Tests, the 95% CI=0.67-0.91 is relatively wide, as it is for the Lateral Tests (ICC=0.71, 95% CI=0.50-0.84) supporting an error of measurement during this tests as a consequence of the equipment.

Regarding the average value for the intrarater reliability (table 10), ICC slightly falls from the anterior (0.88) tests to the posterior (0.84), while the fall is even higher between the posterior to the lateral tests (0.71). On the other hand, the horizontal tests (0.83), seem to be slightly lower than the anterior but equal to the posterior tests. Even though the horizontal tests give a higher average ICC=0.83, the 95% CI (0.67-0.91) is quite wide.

As mentioned earlier, it is important to notice that the anterior tests are the only tests where the mobility is registered when the participant taps on the mat, in other words direct contact between finger and mat.

During the posterior and the lateral tests, a plumb weight is used. Despite the higher ICC (0.84) of the posterior tests compared to the lateral tests (0.71), 95% CI is quite wide in both cases (95% CI 0.68-0.92_{posterior}, 0.50-0.84_{lateral}), with the lateral being the lowest. The same principle applies for the horizontal tests, that despite an excellent intrarater reliability (ICC=0.83), 95% CI reports quite wide values of 0.67-0.91.

The estimates of intrarater reliability of the Test 3 and 4 rate comparably with those of other non-instrumented functional reach tests. Test 3 and 4 are the only ones in the HRSEBT to have a performed reach direction equal to that of Functional Reach (FR) (Duncan, Weiner, Chandler, & Studenski, 1990). Both test 3 and 4 from HRSEBT are performed anteriorly towards A0, equal to that of the FR. The particular tests are performed with a stance leg and a toe-touch leg being slightly different to that of the FR requiring a pure bilateral stance without a toe-touch leg.

FR is a clinical test most similar to HRSEBT and is done by having the subjects maintain a bilateral stance while trying to reach with one hand as forward as possible without moving the position of the feet. The maximum hand reach distance of forward reach is measured by a measuring tape by the examiner. Reliability studies of the FR reported ICC's of 0.92 (Duncan et al., 1990), 0.83 (Donahoe, Turner, & Worrell, 1994) and 0.87 (Niznik, Turner, & Worrell, 1996), which are very similar to what was observed in our study with respect to test 3 and 4 (ICC=0.95 and 0.89, respectively).

Another measure functional reach of the upper extremities found in the literature is the Upper Quarter Y Balance Test (UQYBT - Gorman, Butler, Plisky, & Kiesel, 2012). It is, an upper extremity mobility and stability test that simultaneously require shoulder and core stability while taking the subjects through a large range of motion at the end range of their stability. The UQYBT is a closed kinetic chain test that uses a series of 6 dynamic hand reach tests while the subject maintains a push-up position with the feet no more than 30cm apart. Then the test subject performs maximal reaching distance with the free hand in three directions (medial, superolateral and inferolateral) named in comparison to the stance hand. Three practice trials are allowed prior to testing, after which the maximal reaching distance is registered by the tester. Comparing the intrarater reliability of the anterior tests of the HRSEBT (ICC=0.88, CV=0.77-0.94), being the set of tests similar to the UQYBT tests where participant has direct contact with the mat, the results indicate similar values with those of the UQYBT (0.80-0.99) as

performed by Gorman and colleagues (Gorman et al., 2012), and by Westrick and colleagues (Westrick, Miller, Carow, & Gerber, 2012) ($ICC_{\text{dominant}}=0.91$, $ICC_{\text{non-dominant}}=0.92$).

Table 12: Overview over the ICC and the 95% CI, when that possible, of the Anterior tests of HRSEBT and the corresponding tests of previous reliability studies of tests including Hand Reaches as a measure of mobility/balance.

Comparison of Tests	Reliability ICC (95% CI)
Anterior Tests & SEBT Anterior	0.88 (0.79-0.93) & 0.88 (0.80-0.94)
Anterior Tests & Functional Reach	0.88 & 0.92*/0.83**/0.87***
Anterior & UQYBT	0.88 & 0.91
Anterior Inter & Anterior Intra	0.88 (0.79-0.93) & 0.88 (0.77-0.94)

*(Duncan et al., 1990)

** (Donahoe et al., 1994)

*** (Niznik et al., 1996)

COMPARISON BETWEEN INTRA- AND INTERRATER RELIABILITY

Looking at the results of both the interrater reliability (table 7) and intrarater reliability (table 9), there is a specific pattern registered within them. An overview of the subgroups (table 4) provides a picture of how the different tests are grouped. The reliability of the subgroups for respectively interrater reliability (table 8) and intrarater reliability (table 10) provides information about the difference between the groups as well as the width of their CI. On the other hand, information about the level of the reliability provides information about the level of agreement as well as the fact that 80% of the tests have been registered to have excellent reliability for both inter- and intrarater reliability (table 11). A graphical illustration of both can give a picture of both of them at the same time (Figure 4).

Based on the above mentioned results, grouped in a way providing information about different elements of HRSEBT, it is important to firstly address that there is a certain pattern in the subgroups of the HRSEBT. This results in an excellent reliability of all the anterior tests with a relatively narrow CI for both the inter- and intrarater reliability.

Both the lowest and highest value of the CI for the anterior tests are within excellent level of reliability.

Regarding the rests of the subgroups, all in all, the pattern of the ICC with its corresponding 95% CI would support the thinking process around the use of the equipment and the error of measurement to which that this may result.

Compared with the interater reliability, the average value for the intrarater reliability slightly falls from the anterior tests to the posterior, while the fall is even wider between the posterior to the lateral tests. At the same time, one can notice that the fall is in line with the results from the interater reliability, registering a continues fall from the anterior tests to the lateral tests. On the other hand, when seeing at the values of the intrarater reliability, the horizontal tests, seem to be slightly lower than the anterior but equal to the posterior tests. Even though the horizontal tests give a higher average ICC=0.83, the 95% CI (0.67-0.91) is similar to that of the interater reliability (95% CI 0.62-0.87).

The decrease in terms of ICC can therefore be explained based on the use of the equipment, such as the plumb weight and the rod, resulting in a different projection of the distal part of the equipment compared to the real reaching point of the participant that happens at the proximal part of the equipment. Regarding the plumb weight, this is due to pendulum moments that occur when the rater attempts to adjust the rope proximally to the reaching distance of the participant, without the plumb distally projecting that distance (figure 5).

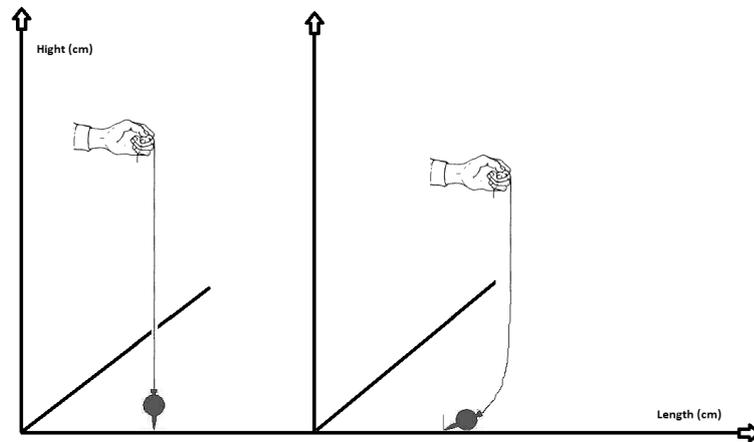


Figure 5: Illustration of the projection of the plumb and the error of measurement that can occur as a consequence of a plumb and the rope.

Within both the interater and intrarater reliability, the speculation in terms of level of experience within the raters is doubly the case. This is due to the fact that the results from the interater (ICC=0.88, 95% CI=0.79-0.93) and intrarater reliability (ICC=0.88, 95% CI=0.77-0.94) are alike, both in terms of ICC but also in terms of 95% CI. On the other hand, despite an excellent ICC registered within the posterior tests, 95% CI is relatively wide. A wide 95% CI has also been registered within the lateral and the horizontal tests. Additionally, the lateral tests are in favour of the interater reliability (ICC=0.78, 95% CI=0.65-0.88) than of the intrarater reliability (ICC=0.71, 95% CI=0.50-0.84), both based on the ICC but also in on 95% CI, with the latter being much wider at the intrarater reliability. Last, but not least, despite a higher ICC reported at the intrarater reliability, 95% CI is quite wide, making it possible to speculate that such a width can have occurred due to unpredicted results when using a weight plumb or rod, rather than experience

Suggestions for method improvement and limitations of the study

Despite the excellent reliability, both inter- and intrarater, the width of 95% CI is relatively wide. Similar results have been registered with the horizontal tests where a rod has been used. This pinpoints towards the need for a more precise way to measure the reaching distance during these tests where the participant does not touch the mat. The plumb weight used could therefore be replaced by a laser pointer which can be worn on the middle finger and be activated when the participant reaches the horizontal plan. Such a tool has been discussed as a further development for this particular set of tests and hopefully providing it with a precise measurement during all the tests. Such equipment can also be applicable during the rotational tests where the participant has his/her arms in parallel with the mat. The laser can point precisely to the reaching point on the mat and therefore reduce measurement errors introduced by the plumb weight.

All in all, our findings provide us with a valuable set of tests in order to test functional mobility. HRSEBT includes a single stance foot with a toe touch foot that points towards the direction the participant is reaching. This gives an advantage in comparison to either bilateral stance or a pure single leg stance with the opposite foot off the mat. The HRSEBT takes also in account balance by not having a pure bilateral stance, but at the same time without making balance a dominant element and therefore becoming a balance test. As for mobility, the single leg stance with the opposite foot off the mat, would be a limiting factor if balance is limited or impaired.

Additionally, the HRSEBT provides guidelines (see Appendix 1) for the addition of rotational tests using hand reaches. This is due to the fact that different tests look at the mobility of different joints, for instance Right SLS Both arms A0 reach to floor may capture possible limitations of mobility of Right dorsiflexion, Right knee flexion and Right hip flexion. Right SLS Both arms P180 overhead reach, on the other hand, may capture limitations of mobility of Right hip extension, Lumbar extension, Thoracic extension, Both scapular depression and posterior tilt and Both shoulder flexion. A description of all the tests and the limitation of mobility is described in Appendix 1.

In other words, it displays a map of reduced reaching distances observed by pinpointing towards the area where mobility may be an issue. This set of tests have similarities with previous tests that include hand reaches, such as Functional Reach and UQYBT. It differs though from those tests as it has been established primarily to map mobility of both upper and lower extremities, and it has included guidelines for the addition of rotational tests. This may be more clinically relevant when the whole kinematic chain of a complex movement seen in daily life and different sports.

CONCLUSION

The HRSEBT is a reliable set of test when used across multiple raters in different settings when raters are trained by an experienced rater. The overall reliability for respectively interrater and intrarater was excellent ($ICC_{Inter}=0.824$, $ICC_{Intra}=0.828$), indicating excellent consistency of measurements both by multiple investigators but also within the same investigator. Despite the varied experience of the investigators in our study, the interrater reliability of the HRSEBT is excellent, which allows us to conclude that HRSEBT can be used with confidence across raters of different experience levels provided that raters attend a course undergoing the basics of the guidelines of the HRSEBT.

Regarding the different subgroups of the HRSEBT, the results indicate excellent intrarater reliability for the Anterior, Posterior, Lateral and the Horizontal tests. On the other hand, results within the intrarater reliability have registered excellent intrarater reliability for the Anterior, Posterior and the Lateral Tests, but fair to good reliability for the Lateral Tests. In comparison to the Anterior Tests, the 95% CI of the other subgroups is relatively wide, which can point towards a need of a more precise equipment regarding the Lateral, Posterior and the Horizontal tests. This is during the fact that during the Anterior tests the participant is having direct contact with the mat when the measurement is registered, while during the Lateral and Posterior tests a weight plumb is used, and during the Horizontal tests a rod is used when the measurement is registered.

The use of a laser pointer has been discussed as a further development for this particular set of tests. Such a tool can be worn by the participant on the top of the

finger; pointing at the maximal reaching distance on the mat could be registered as a measurement outcome. Such a tool can provide this particular set of tests with a precise measurement during all the tests, increasing the reliability and reducing the width of 95% CI. Such equipment can also be used for the rotational tests where the participant has the arms in parallel with the mat.

Considering the above, it can be stated that, professionals in the field of research, performance development and/or physiotherapy may be able to use this tool for assessing dynamic mobility of the upper extremities, lower extremities and the trunk. The HRSEBT is a reliable and inexpensive tool in sports, research and physiotherapy settings.

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Star excursion balance test with hand reaches – APPENDIX 1

3D Mobility screen – combined planes

1. L SLS L arm R45 reach to floor

Purpose: R45 mobility from L foot

Description: Starting position L arm overhead. L SLS with R foot toe touch right P180 with toes pointing towards R45 (target) between 20 and 30 with R hand on hips. Reach to be performed at floor height as far as possible along R45. Arm is to follow the vector when reaching

Measure/documentation: horizontal distance L middle fingers along R45 (cm)

Possible limitations mobility:

- L Hip external rotation
- Decreased L hamstring flexibility (biceps femoris)
- Decreased L dorsiflexion with eversion

2. L SLS R arm L135 overhead reach

Purpose: L135 mobility from L foot

Description: starting position R arm overhead. L SLS with R foot toe touch R90 with heel pointing toward L135 (target) between 20 and 30 with L hand on hips. Reach to be overhead as far as possible along L135. Arm is to follow the vector when reaching

Measure/documentation: horizontal distance R middle finger along L135 (cm)

Possible limitations mobility:

- L hip extension with external rotation
- Lumbar and thoracic extension
- Scapulothoracic depression, posterior tilt and shoulder flexion

3. L SLS R arm L45 reach to floor

Purpose: L45 mobility from L foot

Description: starting position R arm overhead. L SLS with R foot toe touch R90 with toes pointing L45 (target) between 20 and 30 with L hand on hips. Reach to be performed at floor height as far as possible along L45. Arm is to follow the vector when reaching.

Measure/documentation: horizontal distance R middle finger along L45 (cm).

Possible limitations mobility:

- L hip internal rotation
- L hamstring flexibility (semitendinosus, semimembranosus)
- L dorsiflexion (with inversion)

4. L SLS arm R135 posterior overhead reach

Purpose: R135 mobility from L foot

Description: starting position L arm overhead. L SLS with R foot toe touch A0 with heel pointing R135 (target) between 20 and 30 with R hand on hips. Reach to be performed overhead as far as possible along R135. Arm is to follow the vector when reaching.

Measure/documentation: horizontal distance L middle finger along R135 (cm).

Possible limitations mobility:

- L hip internal rotation and extension
- Thoracic extension
- Scapulothoracic depression, posterior tilt and shoulder flexion

5. R SLS R arm L45 reach to floor

Purpose: L45 mobility from R foot

Description: Starting position R arm overhead. R SLS with L foot toe touch P180 with toes pointing towards L45 (target) between 20 and 30 with L hand on hips. Reach to be performed at floor height as far as possible along L45. Arm is to follow the vector when reaching

Measure/documentation: horizontal distance R middle fingers along L45 (cm)

Possible limitations mobility:

- R Hip external rotation
- Decreased R hamstring flexibility (biceps femoris)
- Decreased R dorsiflexion with eversion

6. R SLS L arm R135 overhead reach

Purpose: R135 mobility from R foot

Description: starting position L arm overhead. R SLS with L foot toe touch L90 with heel pointing toward R135 (target) between 20 and 30 with R hand on hips. Reach to be overhead as far as possible along R135. Arm is to follow the vector when reaching

Measure/documentation: horizontal distance L middle finger along R135 (cm)

Possible limitations mobility:

- R hip extension with external rotation
- Lumbar and thoracic extension
- Scapulothoracic depression, posterior tilt and shoulder flexion

7. R SLS L arm R45 reach to floor

Purpose: L45 mobility from L foot

Description: starting position L arm overhead. R SLS with L foot toe touch L90 with toes pointing R45 (target) between 20 and 30 with R hand on hips. Reach to be performed at floor height as far as possible along R45. Arm is to follow the vector when reaching.

Measure/documentation: horizontal distance L middle finger along R45 (cm).

Possible limitations mobility:

- R hip internal rotation
- R hamstring flexibility (semitendinosus, semimembranosus)
- R dorsiflexion (with inversion)

8. R SLS R arm L135 posterior overhead reach

Purpose: L135 mobility from R foot

Description: starting position R arm overhead. R SLS with L foot toe touch A0 with heel pointing L135 (target) between 20 and 30 with L hand on hips. Reach to be performed overhead as far as possible along L135. Arm is to follow the vector when reaching.

Measure/documentation: horizontal distance R middle finger along L135 (cm).

Possible limitations mobility:

- R hip internal rotation and extension
- Thoracic extension
- Scapulothoracic depression, posterior tilt and shoulder flexion

3D Mobility screen – Single plane

1. L SLS B arms A0 reach to floor

Purpose: A0 mobility from L foot

Description: Starting position with arms overhead. L SLS with R foot toe touch R135 with foot pointing A0 (target) between 20 and 30. Reach to be performed at floor height as far as possible along A0. Arms are to follow vector when reaching.

Measure/documentation: horizontal distance B middle fingers along A0 (cm)

Possible limitations mobility:

- L dorsiflexion
- L knee flexion
- L hip flexion

2. L SLS B arms P180 overhead reach

Purpose: P180 mobility from L foot

Description: Starting position with arms overhead. L SLS with R foot toe touch R45 with heel pointing P180 (target) between 20 and 30. Reach to be performed overhead as far as possible along P180. Arms are to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along P180 (cm)

Possible limitations mobility:

- L hip extension
- Lumbar and thoracic extension
- B scapular depression and posterior tilt
- B shoulder flexion

3. L SLS B arms L90 overhead reach

Purpose: L90 overhead mobility from L foot.

Description: Starting position with arms overhead. L SLS with R foot toe touch R135 with foot pointing A0 between 20 and 30 with L hand on hips. Reach to be performed overhead as far as possible along L90. B arms are to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along L90 (cm)

Possible limitations mobility:

- L foot eversion
- L hip abduction
- Lumbar and thoracic L lateral flexion

4. L SLS B arms R90 overhead reach

Purpose: R90 overhead mobility from L foot.

Description: Starting position with arms overhead. L SLS with R foot toe touch L45 with foot pointing A0 between 20 and 30 with R hand on hips. Reach to be performed overhead as far as possible along R90. B arms is to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along R90 (cm)

Possible limitations mobility:

- L foot eversion
- L hip adduction
- Lumbar and thoracic R lateral flexion

5. L SLS B arms L rotational reach at shoulder height

Purpose: L rotational mobility from L foot

Description: Starting position facing A0 with arms anterior at shoulder height. L SLS with R foot toe touch R90 foot pointing A0 between 20 and 30. Rotation to be performed at shoulder height as far as possible to the L.

Measure/documentation: Rotation L of B of middle fingers (degrees)

Possible limitations mobility:

- L midtarsal joint eversion
- L hip internal rotation
- Lumbar and thoracic L rotation

6. L SLS B arms R rotational reach at shoulder height

Purpose: R rotational mobility from L foot

Description: Starting position facing A0 with B arms anterior at shoulder height. L SLS with R foot toe touch R90 foot pointing A0 between 20 and 30. Rotation R to be performed at shoulder height as far as possible to the R.

Measure/documentation: Rotation R of B middle fingers (degrees)

Possible limitations mobility:

- L hip external rotation
- Lumbar and thoracic R rotation

7. R SLS B arms A0 reach to floor

Purpose: A0 mobility from R foot

Description: Starting position B arms overhead. R SLS with L foot toe touch L135 with foot pointing A0 (target) between 20 and 30. Reach to be performed at floor height as far as possible along A0. Arms are to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along A0 (cm)

Possible limitations mobility:

- R dorsiflexion
- R knee flexion
- R hip flexion

8. R SLS B arms P180 overhead reach

Purpose: P180 mobility from R foot

Description: Starting position arms overhead. R SLS with L foot toe touch L45 with heel pointing P180 (target) between 20 and 30. Reach to be performed overhead as far as possible along P180. Arms are to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along P180 (cm)

Possible limitations mobility:

- R hip extension
- Lumbar and thoracic extension
- B scapular depression, posterior tilt and B shoulder flexion

9. R SLS B arms R90 overhead reach

Purpose: R90 overhead mobility from R foot.

Description: Starting position arms overhead. R SLS with L foot toe touch L135 with foot pointing A0 between 20 and 30 with R hand on hips. Reach to be performed overhead as far as possible along R90. Arms are to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along R90 (cm)

Possible limitations mobility:

- R foot eversion
- R hip abduction
- Lumbar and thoracic R lateral flexion

10. R SLS B arms L90 overhead reach

Purpose: L90 overhead mobility from R foot.

Description: Starting position arms overhead. R SLS with L foot toe touch R45 with foot pointing A0 between 20 and 30. Reach to be performed overhead as far as possible along L90. B arms are to follow vector when reaching

Measure/documentation: horizontal distance B middle fingers along L90 (cm)

Possible limitations mobility:

- R foot eversion
- R hip adduction
- Lumbar and thoracic L lateral flexion

11. R SLS B arms R rotational reach at shoulder height

Purpose: R rotational mobility from R foot

Description: Starting position facing A0 with arms anterior at shoulder height. R SLS with L foot toe touch L90 foot pointing A0 between 20 and 30. Rotation to be performed at shoulder height as far as possible to the R.

Measure/documentation: Rotation of B middle fingers (degrees)

Possible limitations mobility:

- R midtarsal joint eversion
- R hip internal rotation
- Lumbar and thoracic R rotation

12. R SLS B arms L rotational reach at shoulder height

Purpose: L rotational mobility from R foot

Description: Starting position facing A0 with arms anterior at shoulder height. R SLS with L foot toe touch L90 foot pointing A0 between 20 and 30. Rotation L to be performed at shoulder height as far as possible to the L.

Measure/documentation: Rotation of B middle fingers (degrees)

Possible limitations mobility:

- L hip external rotation
- Lumbar and thoracic R rotation

Forespørsel om Deltagelse i Prosjektet – Appendix 2

” Inter-rater and intra-rater reliability of functional mobility screen ”

Prosjektet er en del av en doktorgrad ved Norges Idrettshøgskole, og gjennomføres under veiledning av Peter Federolf og Jan Cabri. Prosjektet avsluttes sommeren 2015, men din involvering som forsøksperson vil foregå høst 2014.

Bakgrunn og hensikt

Dette er et spørsmål til deg om å delta i et forskningsstudie for å undersøke inter-rater og intra-rater reliabiliteten til nytt testbatteri for mobilitet. Dette testbatteriet er utviklet av Ola Eriksrud og medarbeidere, og består i dette forsøket av 20 individuelle tester. Konvensjonelle mobilitetstester har til hensikt å kvantifisere resultater isolert for et enkelt segment. Det antas å være lite hensiktsmessig for idrettsbestemte bevegelser hvor flere ledd er i bruk og det er bevegelser i flere plan. Det er et gjensidig avhengighetsforhold mellom ledd i kroppen betyr at hvert ledd påvirker hverandre. Det kan derfor tenkes at konvensjonelle tester kanskje ikke gir et tilfredsstillende bilde av bevegelsesutslag i leddene ved idrettsrelaterte bevegelser, som ofte forgår stående. Vårt testbatteri har til hensikt å se på bevegelsesutslaget i flere ledd samtidig ved mer funksjonelle og idrettsspesifikke bevegelser. Vi ønsker å undersøke reliabiliteten til testbatteriet ved bruke tre forskjellige testere for å undersøke både inter- og intrarater reliabilitet. Interrater reliabilitet ser på reproduserbarheten av testresultat mellom ulike testere, mens intrarater reliabilitet ser på reproduserbarheten hos en enkelt tetster. Det er ingen spesielle krav i dette studie, bortsett fra at du må være mann, frisk og mellom 16 og 40 år.

Omfang

Hvis du velger å delta i studien, vil du gjennomgå ulike tester på et tidspunkt som passer for deg. Testingen foregår i laboratoriene på Norges idrettshøgskole.

Deltagelse i prosjektet vil kreve at du møter fire ganger for å bli testet på biomekanisk laboratorium ved Norges Idrettshøgskole. Hver test varer fra 45 minutter til 1 time.

Gjennomføring

- Antropometriske målinger: høyde, armlengde, beinlengde og vingspenn
- Det er 20 ulike mobilitetstester som skal gjennomføres på en testmatte. Se vedlegg A for detaljer om disse testene.

Fordeler og ulemper ved å delta i studien

Testene i prosjektet vil ikke forårsake store ubehag, men ved noen tilfeller kan noe stølhet forekomme. Denne studien vil dermed innebære svært få ulemper for deg.

Ved å delta i studien vil du få informasjon om din mobilitet ved funksjonelle bevegelser. Når studien avsluttes, vil du kunne sammenligne dine egne målinger med gjennomsnittsverdiene fra alle deltagerne i prosjektet.

Målemetoder

Det er manuelle målemetoder for de ulike antropometriske målingene. Videre kvantifiseres de ulike mobilitetstestene i centimeter eller grader på en testmatt

Din sikkerhet

Informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene og testresultatene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En tallkode knytter deg til dine opplysninger og testresultater gjennom en navneliste.

Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Når resultatene fra prosjektet er ferdig behandlet og prosjektet er avsluttet, vil navnelisten bli slettet, slik at dine resultater ikke kan spores tilbake til deg. Prosjektet planlegges å avsluttes innen utgangen av 2014.

Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Det er frivillig å delta i studien. Du kan når som helst, og uten å oppgi noen grunn, trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for deg. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke

uten at det vil få konsekvenser for deg. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte **Stavros Litsos telefon +47 48257013 eller stavros.litsos@gmail.com**.

Prosjektet er meldt til Personvernombudet for forskning (Norsk samfunnsvitenskapelig datatjeneste AS)

og det er godkjent av Regional komité for medisinsk forskningsetikk.

Dersom du har spørsmål angående prosjektet, kan du kontakte:

Ola Eriksrud, telefon +47 97 61 78 93, eller epost ola.eriksrud@nih.no

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Ola Eriksrud

Ytterligere informasjon om studien finnes i kapittel A – utdypende forklaring av hva studien innebærer.

Ytterligere informasjon om personvern og forsikring finnes i kapittel B – Personvern, økonomi og forsikring.

Samtykkeerklæring følger etter kapittel B.

Kapittel A- utdypende forklaring av hva studien innebærer

Kriterier for deltakelse

A: Inklusjonskriterier

- Du må være fysisk aktiv mann mellom 16 og 40 år.

B: Eksklusjonskriterier

- Du kan ikke ha funksjonsforstyrrende muskel-skjelett diagnose i beina og/eller ryggen.
- Du kan ikke ha hatt skade i underekstremiteten i løpet av de siste seks månedene som har satt deg utenfor aktivitet/trening i mer enn 7 dager.
- Du kan ikke noen gang ha vært gjennom rygg, skulder, hoft-, kne- eller fotoperasjon.

Bakgrunnsinformasjon om studien

I denne studien er det mobilitet av ulike ledd og regioner i ulike retninger som er av interesse. Mobilitet er grunnleggende for enhver fysisk prestasjonsevne.

Mobilitet måles ofte i dag i mage- eller ryggliggende posisjoner eller sittende. Ett og ett ledd blir målt. Det er ikke slik man beveger seg i det daglige liv eller på idrettsarenaen. Der vil det være et samspill mellom ulike ledd i form av mobilitet. Vi har utviklet 20 tester som har blitt testet for validitet, nå ønsker vi å teste både inter- og intrarater reliabilitet.

Tidsskjema – hva skjer, og når skjer det?

Rekruttering og testing av forsøkspersoner vil foregå høst 2014. Når du har lest gjennom denne informasjonen, vurderer du om du ønsker å delta i studien. Når du har tatt en avgjørelse, fyller du ut samtykkeerklæringen på siste side, og returnerer

den til Ola Eriksrud, Fredrik Sæland, eller Stavros Litsos. Etter at du har gitt ditt samtykke, avtaler vi et tidspunkt for testing som passer for deg.

Du kan endre din avgjørelse om å delta/ikke delta når som helst. Du kan også velge å avbryte testene underveis, hvis du ønsker det. Du vil ikke bli bedt om å oppgi nærmere forklaring eller årsak hvis du trekker deg.

Testingen gjennomføres til avtalt tid, i løpet av høsten (August – Oktober) 2014.

Undersøkelsene som blir gjort av deg

Du møter til testing iført treningstøy som det er lett å beveges seg i. Videre vil testene gjennomføres uten skotøy.

Følgende antropometriske data vil bli målt:

- Høyde
- Arm lengde høyre og venstre
- Legg lengde høyre og venstre
- Vingspenn

Det vil totalt bli gjennomført 20 tester, 10 på hvert bein, på en testmatte (Figur 1).

Testmatten er basert på 8 vektorer som deler matten i 8 like store deler. 16 av testene er å se hvor langt man klarer å strekke høyre, venstre eller begge hender langs med disse vektorene. Dette måles i centimeter. De 4 siste testene er hvor

langt man kan rotere til både høyre og venstre stående på hvert bein. Disse rotasjonene måles i grader.

Mulige fordeler

Man blir bevisst på sin egen evne til å bevege seg i ulike retninger og sin egen mobilitet

Mulige ulemper

Det er ikke gjort kjent noen mulige bivirkninger, ubehag eller ulemper ved å delta i studien annet enn noe støyhet kan forekomme i etterkant.

Studiedeltakerens ansvar

Ved å delta i studien har du ansvar for å komme til avtalte tider, evt. avlyse i god tid i forveien om oppsatt dato/tid for møtet ikke passer.

Kapittel B - Personvern, økonomi og forsikring

Personvern

Opplysninger som registreres om deg er: Navn, alder, høyde, armlengde, legglengde, vingspenn og resultater fra de 20 ulike testene.

Informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle opplysningene og prøvene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En tallkode knytter deg til dine opplysninger og testresultater gjennom en navneliste.

Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Når resultatene fra prosjektet er ferdig behandlet og prosjektet er avsluttet, vil navnelistene bli slettet, slik at dine resultater ikke kan spores tilbake til deg. Prosjektet planlegges å avsluttes innen utgangen av 2014.

Andre forskere ved Norges idrettshøgskole vil kunne be om tilgang til det anonyme materialet, til bruk i sammenligning med andre grupper idrettsutøvere eller personer.

Norges idrettshøgskole ved administrerende direktør er databehandlingsansvarlig.

Rett til innsyn og sletting av opplysninger om deg og sletting av informasjon

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de

opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Økonomi og Norges idrettshøgskoles rolle

Studien er finansiert gjennom midler fra Norges idrettshøgskole og Seksjon for Fysisk Prestasjonsevne. Denne finansieringen innebærer ingen interessekonflikter, etiske eller praktiske utfordringer.

Forsikring

Staten er selvassurandør

Informasjon om utfallet av studien

Som deltager i prosjektet har du rett til å få opplyst både dine egne resultater, og informasjon om resultatene av studien totalt sett. Du kan få tilsendt informasjonen ved å kontakte stavros.litsos@gmail.com

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)

SAMTYKKEERKLÆRING

FORESPØRSEL OM DELTAKELSE I PROSJEKTET:
"Inter-rater and intra-rater reliability of functional mobility
screen"

SAMTYKKEERKLÆRING

Jeg har mottatt skriftlig og muntlig informasjon om studien "Inter-rater and intra-rater reliability of functional mobility screen". Jeg er klar over at jeg kan trekke meg fra undersøkelsen på et hvilket som helst tidspunkt.

Sted

Dato

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Underskrift spiller

.....
Underskrift foresatt

.....
Navn med blokkbokstaver

Adresse

Mobiltelefon

E-postadresse

