A New Tool to Measure Isometric Knee Flexor & Extensor Strength in Older Adults

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Background

Purpose

To determine whether the HUR Performance Recorder (PR1) is a tool that could be confidently used as an outcome measure in rehabilitation and research.

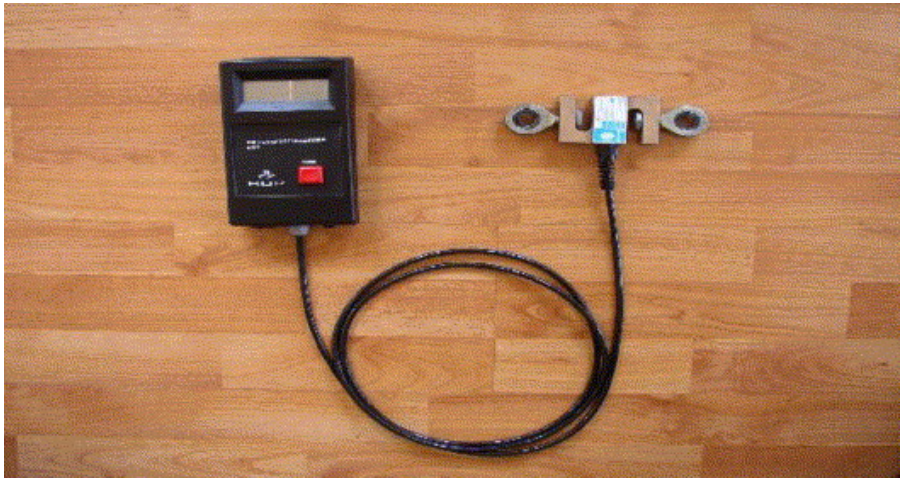
To test the HUR PR1's:

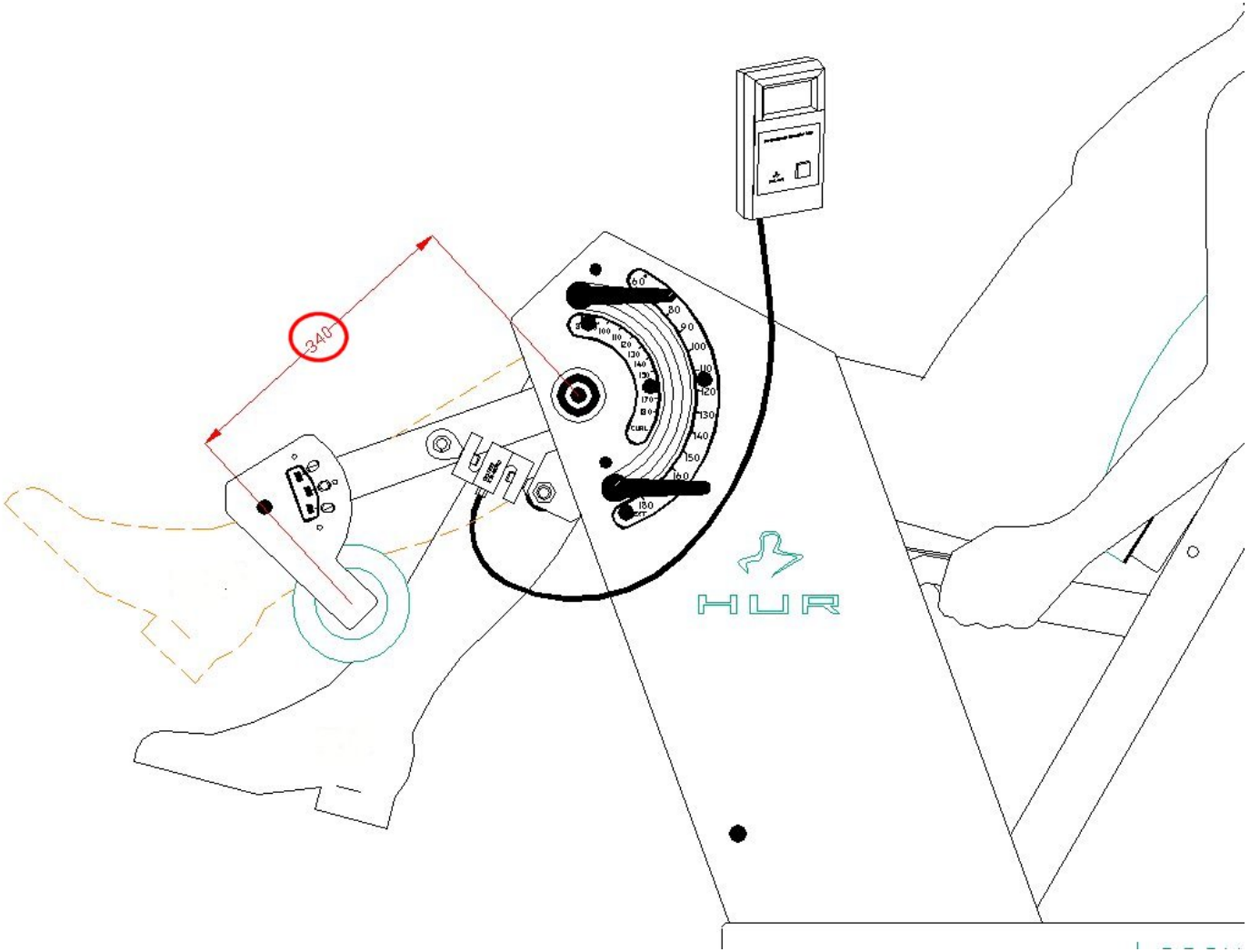
- intra-rater reliability
- inter-rater reliability
- convergent validity against the Biodex dynamometer.

What is the HUR PR1?

HUR PR1

HUR 5530




340
HUR

Why Measure Strength?

- Outcome Measure
  - Rehabilitation
  - Research

- Strength may determine:
  - functional mobility
  - ability to perform ADL's

Why Isometric Strength?

- Simple to perform, compare, & reproduce
- Strong predictor of functional capacity

Why Older Adults?

- Canada's aging population
- OA prevalence
  - 3rd most common chronic condition in Canada
- Activity promotion

Why Knee Flexors/Extensors?

- Knee OA
- Predictive of function
- Limitations of other methods

Why Biodex?

- The gold standard for validity and reliability in testing muscle strength

- WHY NOT JUST USE BIODEX?
  - Access
  - Cost

HUR PR1

- Affordable
- Accessible
- Has not yet been tested
- Potential uses in future rehab and research projects

Methods

Subjects

- Healthy independently living older adults from lower mainland
  - Inclusion criteria
    - 55-75 years of age
  - Exclusion criteria
    - Cardiovascular disease, neuromuscular or musculoskeletal disorders
      - Par-Q
- No selection criteria for current physical activity level

Subjects

- Recruitment – Convenience sample
  - Vancouver Community Centres
  - UBC Changing Aging Program
  - Word of mouth

Sample Size

- Common statistical practice:
  - Alpha level 0.05
  - Power $\geq$ 0.80

- Assumptions
  - There will not be a great deviation between the HUR PR1 tests
  - There will not be a great deviation between the HUR PR1 and Biodex

Sample Size

Sample Sizes needed for correlation coefficient (r)

r									
Power	.10	.20	.30	.40	.50	.60	.70	.80	.90
α=.05									
.70	470	117	52	28	18	12	8	6	4
.80	617	153	68	37	22	15	10	7	5
.90	854	211	92	50	31	20	13	9	6

Adapted from Table C.6 in Portney, L. and M. Watkins , *Foundations of Clinical Research Applications to Practice*

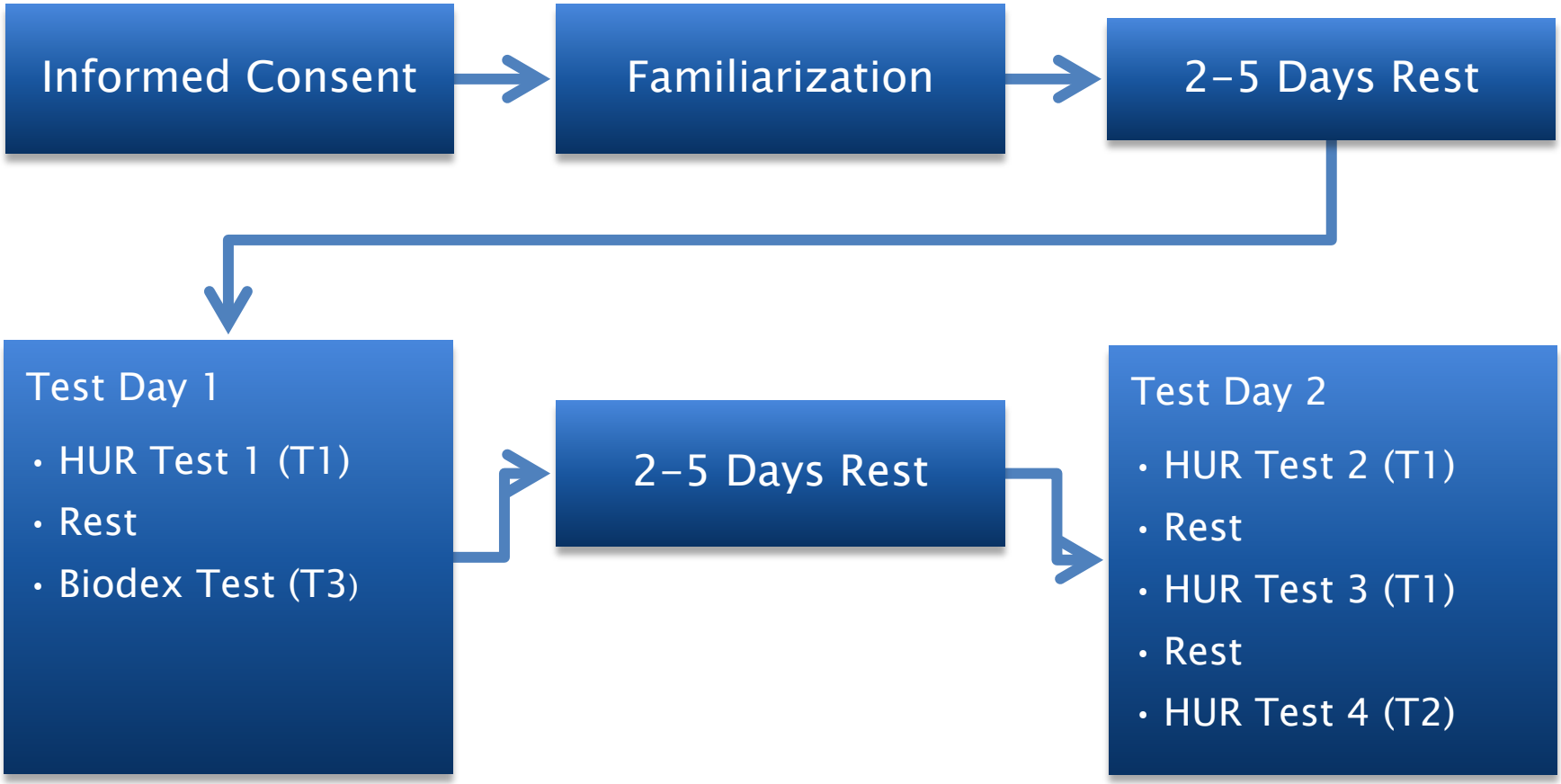
Instrumentation

- HUR 5530 and PR1
  - Calibration as per manufacturer*
  - Fixed joint angle
    - Lateral epicondyle in-line with lever arm rotation axis
    - Assess joint angle with goniometer
  - Ankle pad proximal to malleoli for comfort
- Measure = Force (kg)
- Biodex
  - Calibration as per manufacturer
  - Angles to match HUR
- Measure = Peak Torque (Nm)

Study Design

- Test-Retest Reliability – HUR PR1
  - Intra-rater reliability
  - Inter-rater reliability
- Convergent validity – Biodex vs. HUR

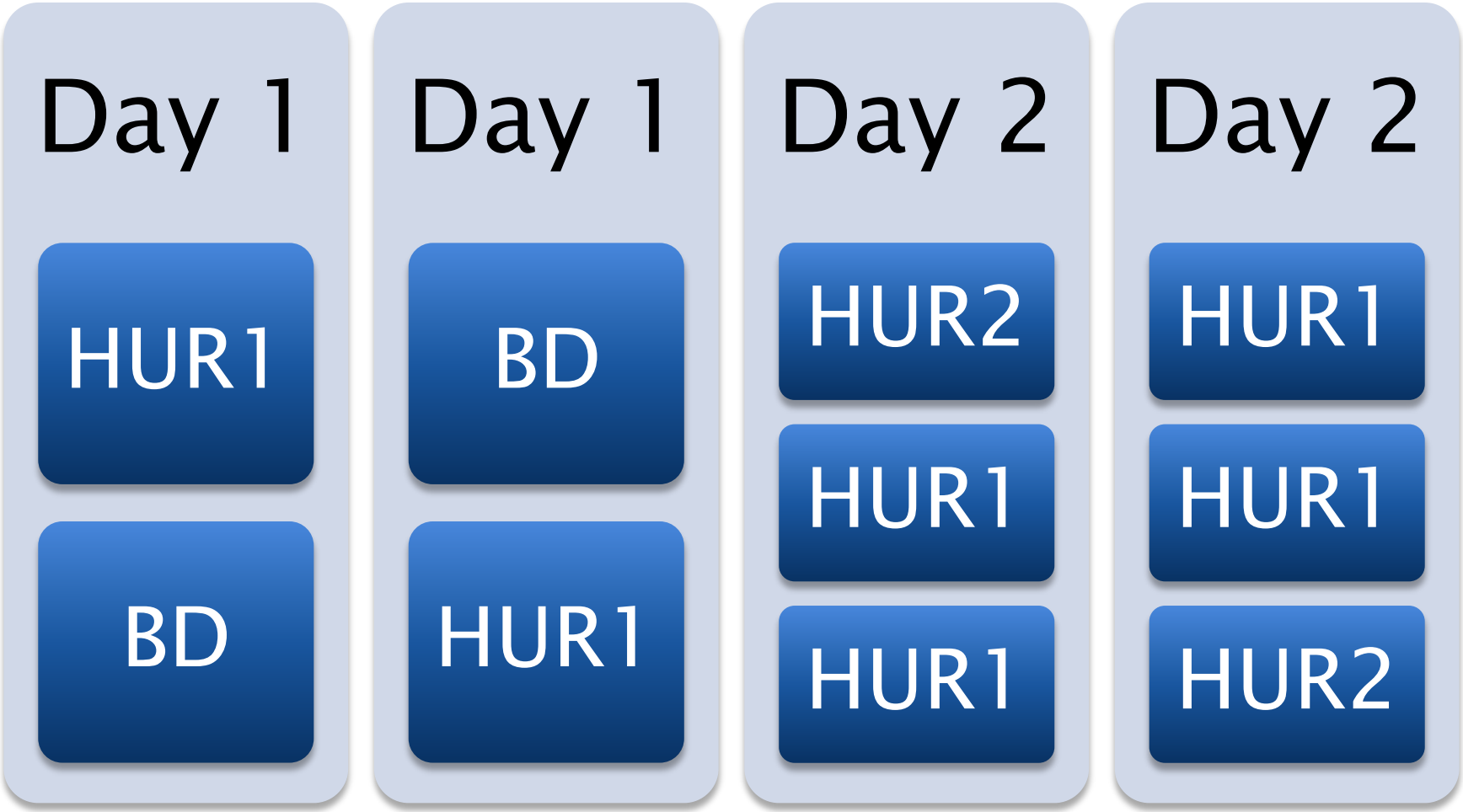
Design


Informed Consent
Familiarization
2-5 Days Rest
Test Day 1
• HUR Test 1 (T1)
• Rest
• Biodex Test (T3)
2-5 Days Rest
Test Day 2
• HUR Test 2 (T1)
• Rest
• HUR Test 3 (T1)
• Rest
• HUR Test 4 (T2)

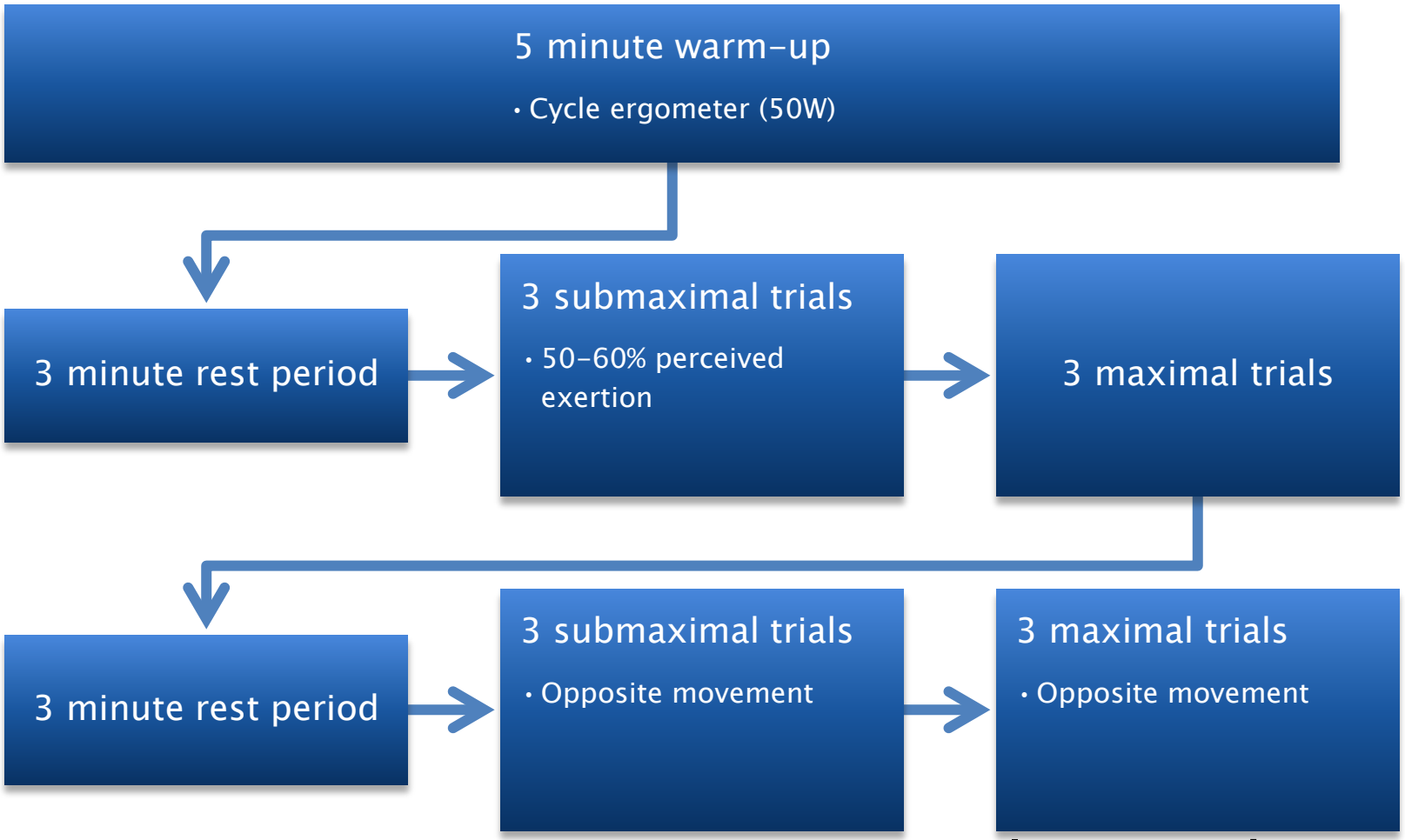
Randomization

- Randomized and counter-balanced
  (Using concealed envelope)
  - Test Day 1 – Randomized order of tests
  - Test Day 2 – Randomized order of examiners
  - Flexion first vs. Extension first
    - Alternated for each testing session

Randomization Options



Protocol



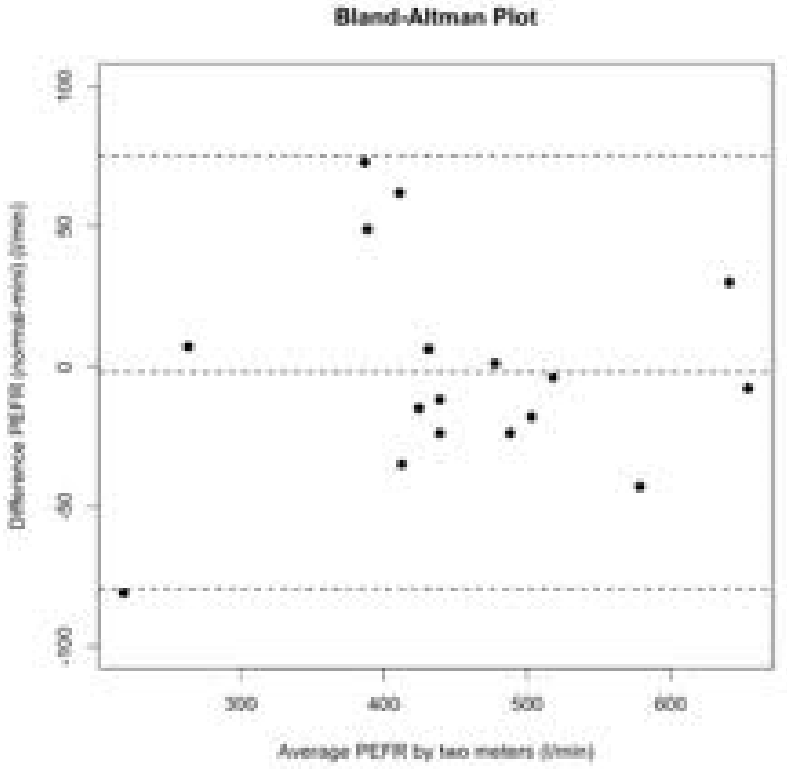
- Dominant leg used

Data Analysis

- Data from HUR PR1 converted from kilograms to peak torque (Nm)
  - Mean of 3 trials
  - Group mean
- Max and mean torque compared using SPSS statistical software

Data Analysis

- Reliability
  - ICC
  - Pearson *r*
- Validity
  - Pearson *r*
  - Bland-Altman Plot



Results

Participant Characteristics

Table 1. Participant characteristics

	All Participants n = 12 Mean (SD)	Male n = 6 Mean (SD)	Female n = 6 Mean (SD)
Age (years)	63.5 ± 5.6	65.2 ± 6.3	61.8 ± 4.8
Height (m)	1.73 ± 0.09	1.80 ± 0.04	1.66 ± 0.06
Weight (kg)	84.5 ± 22.5	100.7 ± 21.0	68.4 ± 6.7
BMI (kg/m^2)	28.0 ± 5.5	31.2 ± 6.2	24.9 ± 2.2
Dominance: n (%) Right Left	 10 (83%) 2 (17%)	 5 (83%) 1 (17%)	 5 (83%) 1 (17%)

Calibration

- HUR PC software issues
- Defaulted to zeroing HUR PR1
- Retested select subjects with calibration post-data collection
  - Regression equation
    - n=3

Intra-rater Reliability

Average Torque	*r*
Flexion	.897
Extension	.893

Maximum Torque	*r*
Flexion	.753
Extension	.943

$p < 0.005$

Intra-rater Reliability

Intra-class Correlation Coefficient (ICC)
(CI = Confidence Interval)

Reliability	Intra-rater Average (95% CI)	Intra-rater Maximum (95% CI)
Flexion	.893 (.684 - .968)	.727 (.316 - .912)
Extension	.886 (.650 - .966)	.929 (.773 - .939)

Inter-rater Reliability

Average Torque	*r*
Flexion	.881
Extension	.886

Maximum Torque	*r*
Flexion	.749
Extension	.954

$p < 0.005$

Inter-rater Reliability

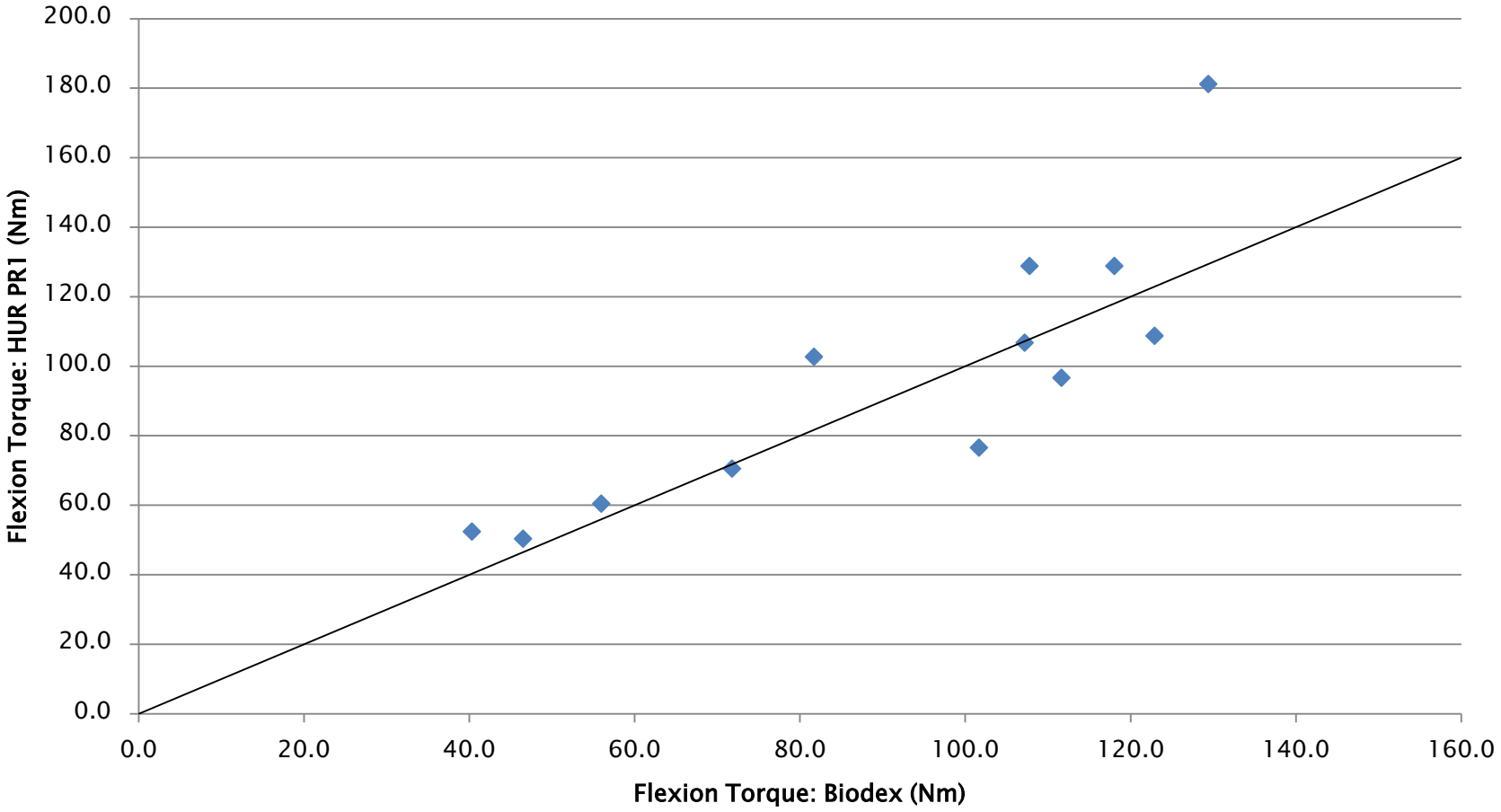
Intra-class Correlation Coefficient (ICC)
(CI = Confidence Interval)

Reliability	Inter-rater Average (95% CI)	Inter-rater Maximum (95% CI)
Flexion	.889 (.660 - .967)	.746 (.347 - .919)
Extension	.886 (.662 - .966)	.934 (.739 - .982)

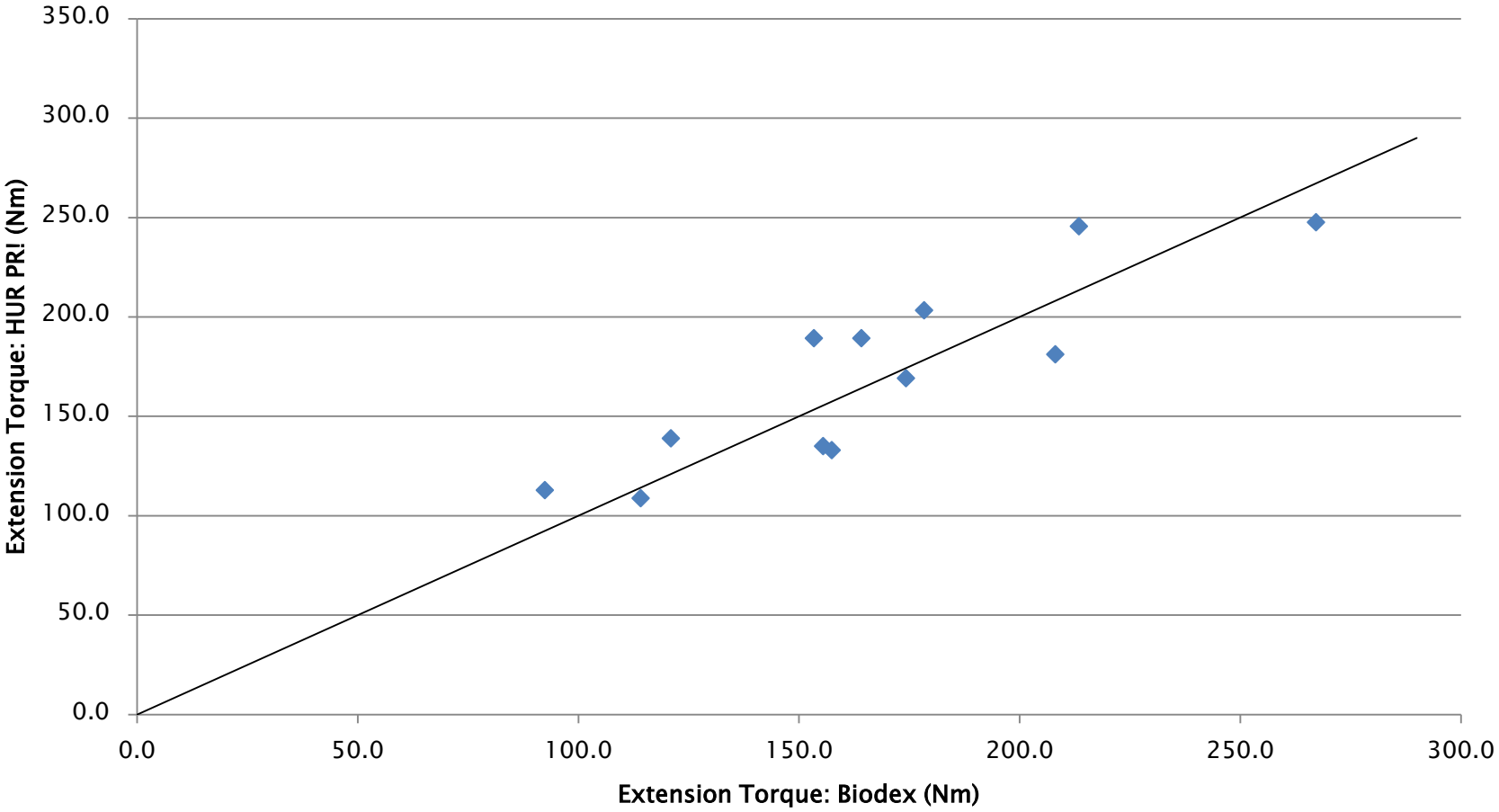
Validity

Biodex vs. HUR PR1	*r*	*p*
Flexion	.847	.001
Extension	.873	.000

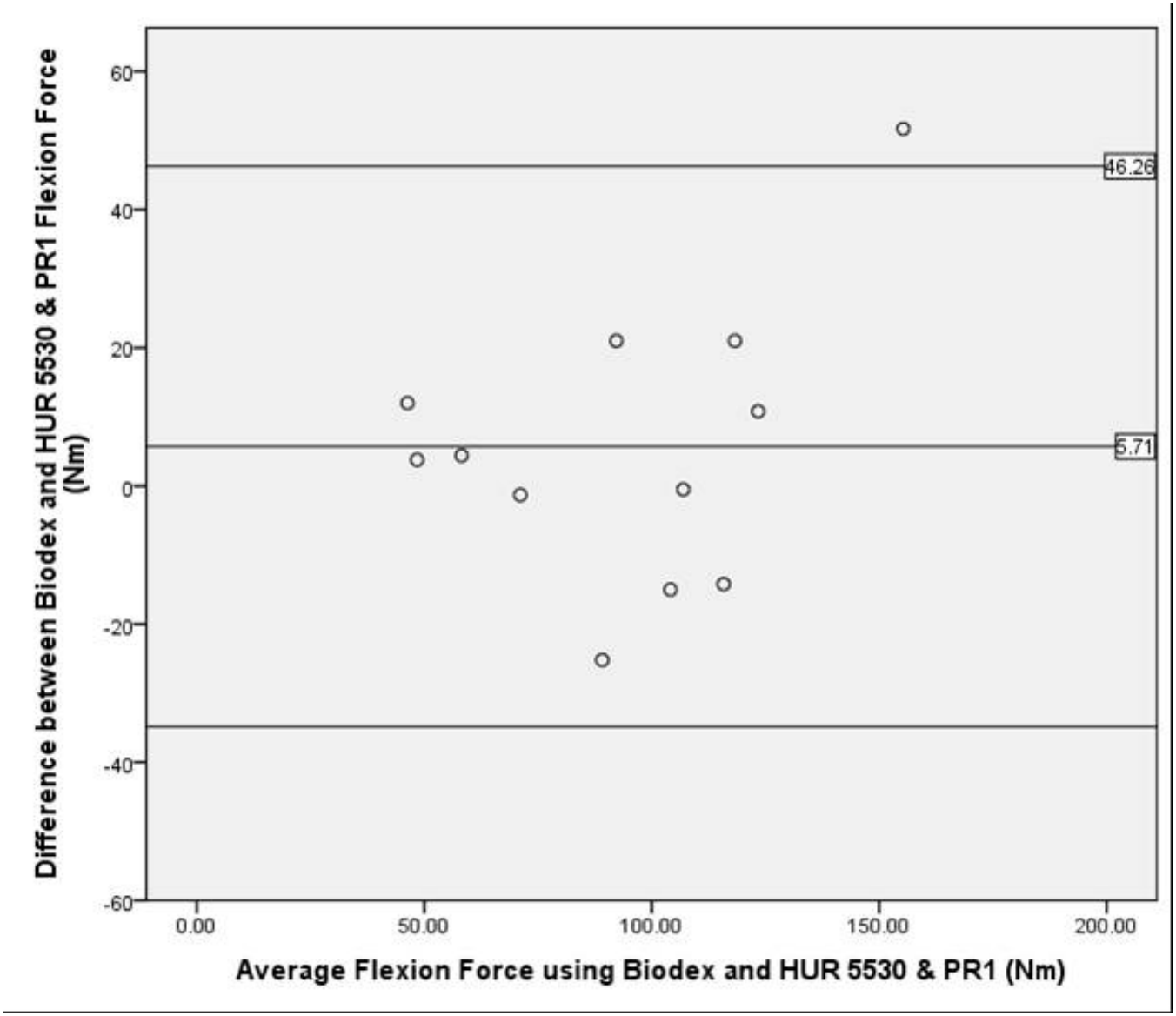
Validity: Flexion Line of Identity



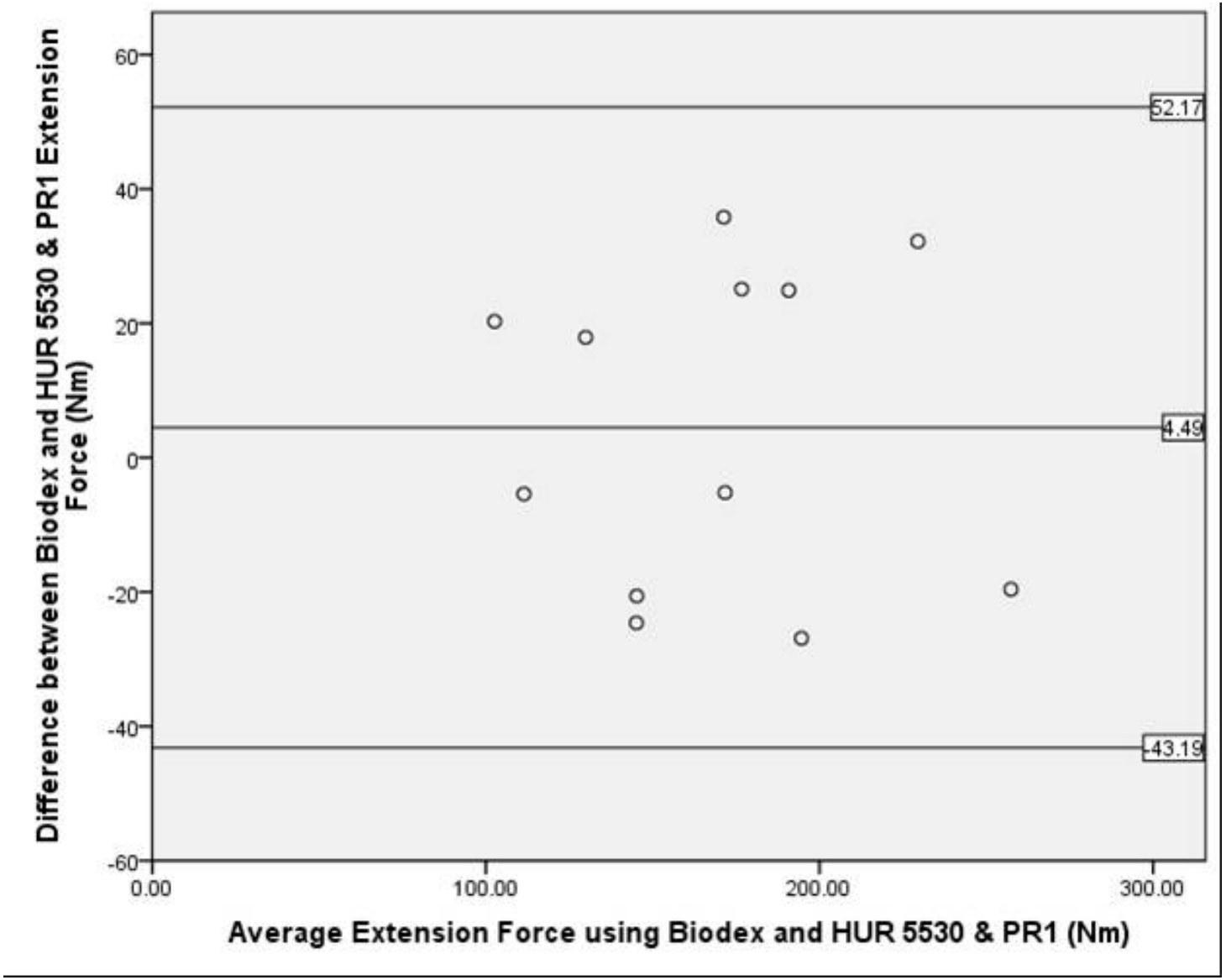
Validity: Ext. Line of Identity



Bland-Altman Plot: Flexion



Bland-Altman Plot: Extension



Discussion

Reliability

- Good intra- and inter-rater reliability
  - Repeatability of the force transducer
  - Standardized protocol

- Extension vs. Flexion
  - Trend toward greater reliability with extension
  - Error from counter-moment force
    - Counter-moment greater from extensors
  - HUR 5530 set-up
    - Immovable pad vs. straps

Validity

- Good criterion-referenced validity to Biodex
- Unbiased error
- Wide confidence limits
  - Calibration issues?
    - Regression equation

Problems and Challenges

- HUR PR1 Unit
  - Major issues with software
  - Hardware malfunctions
  - Calibration issues
  - Limited access to IT support
- Recruiting
  - Slow to recruit adequate sample size
- Time
  - Constraints related to course schedule

Limitations

- Data extrapolated using a regression formula based on a sample within the sample
- Predetermined joint angle limits clinical applications
- Generalizability
  - Healthy older adults

Future Research

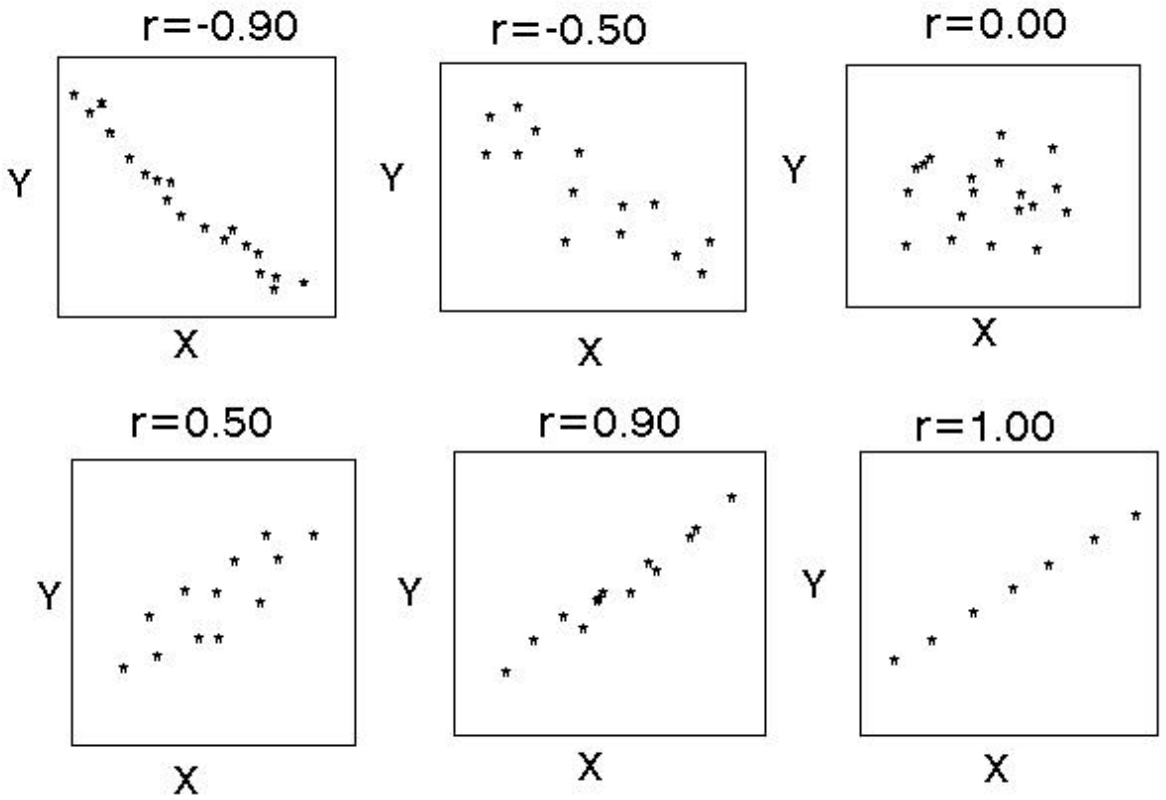
- Calibrated trials
  - Using HUR PR1 software
- Use with different exercise machines?
  - E.g. different movements/muscle groups
- Different age groups?
- Clinical populations?

Conclusion

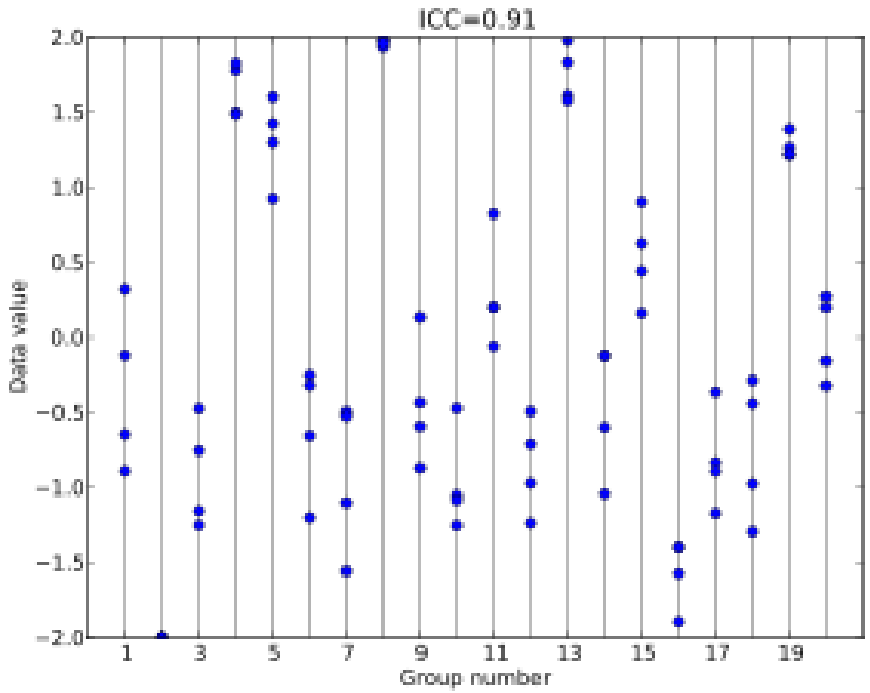
- Reliable
- Valid
- Software limitations
- Practical-knee flexion/extension

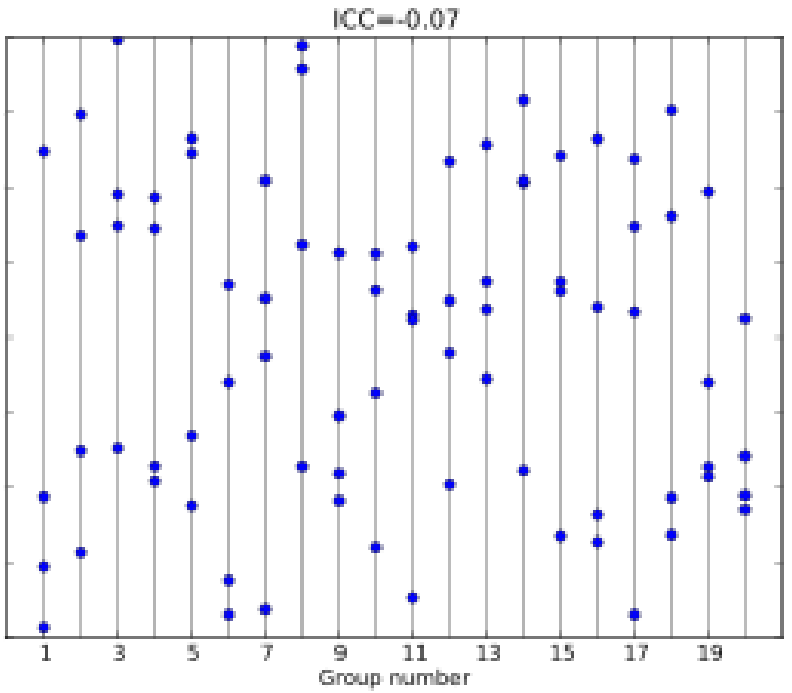
THANK YOU!

Correlation Coefficient



Intraclass Correlation Coefficient





Large ICC

Small ICC

Limits of Agreement