Two Tests to Assess Quadriceps Strength in the Physiotherapy Clinic: Comparison of Measurement Properties

Marc Beer[1,2] **Heiner Baur**[1]

[1] Bern University of Applied Sciences, School of Health Professions, Physiotherapy, Bern, Switzerland [2] Zénith Physiothérapie 2300, La Chaux-de-Fonds, Switzerland

Background

- Strength of the quadriceps muscle must be monitored during rehabilitation after knee injury or surgery [1].
- Without access to an isokinetic dynamometer, physiotherapists in private clinics can measure isometric strength with a fixed hand-held dynamometer (HHD), or isotonic strength with a 1-repetition maximum test (1RM) on a leg extension machine. But which test must be used preferably?
- Evidence about measurement properties is lacking [2]. It is unclear which test identifies side-to-side deficits more efficiently (diagnostic accuracy), correlates better with vertical jump height (construct validity) and has lower intra-rater measurement error.

Objectives

Compare diagnostic accuracy, construct validity and intra-rater measurement error of HHD and 1RM, in the practical context of a private physiotherapy clinic.

Methods

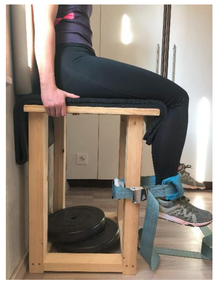
Participants
- 20 adults
- Knee injury or surgery in the last 2 years
- Pain-free single-leg vertical hop (SLVH)

Protocol
Performed 2 times within 7 days:
- HHD: maximal isometric quadriceps strength in N/kgbw
- SLVH: single-leg jump height in cm
- 1RM: maximal isotonic quadriceps strength in kg/kgbw

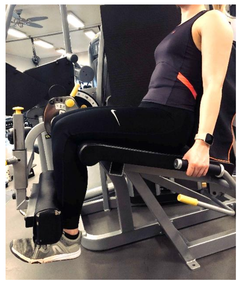
Diagnostic accuracy
- Comparison of mean limb symmetry index (LSI) values for HHD and 1RM with a paired t-test.
- Smallest detectable change (SDC_{90}) of LSI to help interpretation.

Construct validity
- Correlation of strength values with jump height via Spearman's rho.
- Comparison of correlations via Fischer z-transformation.

Intra-rater measurement error
- SDC_{90} of strength values in % for each strength test.



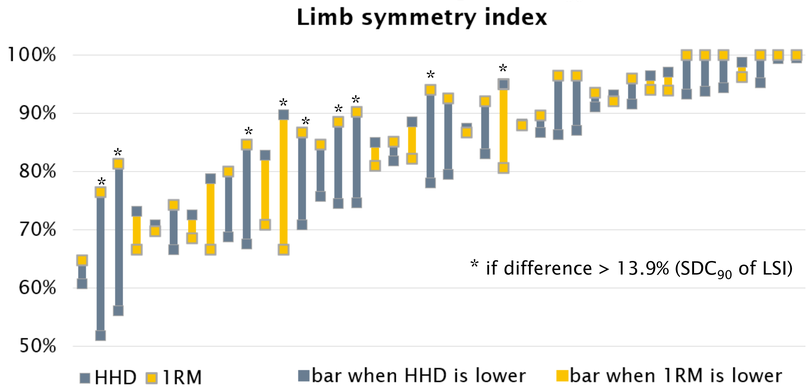
HHD



1RM

Results

Diagnostic accuracy
Mean LSI was 3.6% [95CI 0.4, 6.9] lower for HHD (p= 0.03*). 9 out of 40 lower limbs had differences exceeding the SDC_{90} of LSI.



Construct validity

	Correlation with SLVH	Strength of correlation	Difference [95CI]	p
HHD uninvolved	0.37	Fair	**-0.27 [-0.68, -0.07]**	0.01*
1RM uninvolved	0.65	Moderately strong		
HHD involved	0.47	Fair	**-0.13 [-0.57, 0.20]**	0.34
1RM involved	0.60	Moderately strong		

n = 40
95CI: confidence interval 95%, SLVH: single leg vertical hop, HHD: hand-held dynamometer, 1RM: 1 repetition max

Intra-rater measurement error (T1-T2)

	Difference in % (mean ± SD)	$ICC_{3.1}$ [95CI]	SDC_{90} (%)
HHD uninvolved	-3.5 ± 4.6	0.96 [0.89, 0.98]	**7.6**
1RM uninvolved	-2.6 ± 7.5	0.96 [0.90, 0.98]	**12.3**
HHD involved	-3.8 ± 8.1	0.91 [0.78, 0.96]	**13.3**
1RM involved	-1.5 ± 7.8	0.94 [0.85, 0.98]	**12.8**

n = 19
T1: Test 1, T2: Test 2, SD: standard deviation, ICC: intraclass correlation coefficient, 95CI: confidence interval 95%, SEM: standard error of measurement, SDC90: smallest detectable change 90% confidence, HHD: hand-held dynamometer, 1RM: 1 repetition max

Discussion

- HHD measured significantly smaller LSIs than 1RM, but only in a small subgroup.
- 1RM had better correlations with SLVH than HHD.
- Intra-rater measurement error was similar for both tests.
- The findings are valid for the protocols and population included in this study.

Clinical implications

- When beginning rehabilitation, both strength tests should be used temporarily to identify which one measures lower LSIs for that individual.
- If the goal is to measure quadriceps strength related to jump height, 1RM should be used.
- When assessing modifications of strength levels, every change below 13% can be considered as measurement error for both tests.

References

[1] Kotsifaki R, Korakakis V, King E, Barbosa O, Maree D, Pantouveris M, et al. Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction. Br J Sports Med. 2023;57:500–14.

[2] Urhausen AP, Berg B, Øiestad BE, Whittaker JL, Culvenor AG, Crossley KM, et al. Measurement properties for muscle strength tests following anterior cruciate ligament and/or meniscus injury: What tests to use and where do we need to go? A systematic review with meta-analyses for the OPTIKNEE consensus. Br J Sports Med. 2022;56:1422–31.

Bern University of Applied Sciences

Zénith 2300 Physiothérapie

▶ Bern University of Applied Sciences, School of Health Professions, Physiotherapy

Contact: marc.beer@bluewin.ch

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