

Table i. Summary of the findings of the articles identified for inclusion

Authors	Journal (yr)	Title	Level of evidence	Methodology	Key results
Muscle strength in hip pathology other than FAI (adults)					
Poulsen et al¹	<i>BMC Musculoskeletal Disord</i> 2012	Reproducibility of range of motion and muscle strength measurements in patients with hip osteoarthritis - an inter-rater study	4	4 blinded raters; (2 orthopaedists examined 48 pts); (2 chiropractors examined 61 pts); Muscle strength and range of motion using goniometer; HHD used	Reliability of muscle strength: Orthopaedists ICC 0.52 to 0.85; Chiropractors ICC 0.38 to 0.81; ICC highest for hip flexion
Thorborg et al²	<i>Am J Sports Med</i> 2011	Hip Adduction and Abduction Strength Profiles in Elite Soccer Players Implications for Clinical Evaluation of Hip Adductor Muscle Recovery After Injury	3	Assessment of symmetry of hip abduction and adduction strength in non-injured elite sportsmen; To create a profile for 'normal' strength; HHD used; n = 100 men (age 20 to 28 yrs)	Dominant side was stronger in adduction and abduction (3% and 4% respectively); Adduction was stronger than abduction; No difference between abduction/adduction ratio between the two sides. This is suggested as a marker of evaluating recovery in adductor injury
Wang et al³	<i>Arch Phys Med Rehabil</i> 2002	Test-retest strength reliability: hand-held dynamometry in community-dwelling elderly fallers.	4	HHD, standardised protocol to test lower limb muscle strength in elderly fallers; (age 61 to 90 yrs); n = 41 pts	ICC: Hip flexors: 0.99; Hip abductors: 0.99; Hip extensors (standing): 0.99
Pua et al⁴	<i>Arch Phys Med Rehabil</i> 2008	Intrarater test-retest reliability of hip range of motion and hip muscle strength measurements in persons with hip osteoarthritis.	4	Hip muscle strength and range of movement; HHD used for isometric make tests; n = 22 (age 50 to 84 yrs)	Intra-rater reliability: (0.84 to 0.97); ICC for hip: Extensors & rotators 0.98; Abductors 0.84; Flexors: 0.87; Extensors: 0.97 (supine)
Sherrington and Lord⁵	<i>Clin Rehabil</i> 2005	Reliability of simple portable tests of physical performance in older people after hip fracture.	4	Strength, balance, gait, and function measured (HHD used for strength); n = 30	Hip abductor strength only; ICC 0.86
Arokoski et al⁶	<i>J Rheumatol</i> 2002	Hip muscle strength and muscle cross sectional area in men with and without hip osteoarthritis.	3	Hip muscle strength in OA vs controls; HHD used; 27 men with OA vs 30 controls	ICC: OA: 0.84 to 0.98; Controls: 0.7 to 0.94
Muscle strength in healthy adults					
Meyer et al⁷	<i>PLoS One</i> 2010	Test-Retest Reliability of Innovated Strength Tests for Hip Muscles	2	Two measurements one week apart; Standardised protocol; Same investigator; MDD used for Isometric and isokinetic; Hip girdle muscles with 10 minute warm up; n = 18 Mean age 44 yrs	First attempt at define 'normal' data for hip muscle strength; Moderate to high reliability – ICC > 0.7; Adduction and extension least reliable
Schmidt et al⁸	<i>Physiother Theory Pract</i> 2013	Comparative reliability of the make and break tests for hip abduction assessment	4	To estimate inter-rater reliability; n = 39 (Healthy 21 to 70 yrs); Hip abduction, two raters; 16 ratings per participant, using HHD	Both reliable (> 0.87); Make test more reliable
Lee and Powers⁹	<i>J Orthop Sports Phys Ther</i> 2013	Description of a Weight-Bearing Method to Assess Hip Abductor and External Rotator Muscle Performance	4	Assessment of abductor and external rotator strength on weight bearing; Force transducer positioned around the distal thigh (HHD); n = 20 Tested on two separate days	High intra-rater reliability; ICC = 0.99
Muscle strength in paediatric population					
Hébert et al¹⁰	<i>Pediatr Phys Ther</i> 2011	Isometric Muscle Strength in Youth Assessed by Hand-held Dynamometry: A Feasibility, Reliability, and Validity Study	4	Upper and lower limbs tested; Isometric make test; Paediatric (age 4 to 17.5 yrs); HHD & MDD used; n = 74	Interrater mean ICC 0.67 to 0.96; Intrarater mean ICC 0.67 to 0.98; Standard error was highest for hip extensors
Katz-Leurer et al¹¹	<i>Pediatr Phys Ther</i> 2008	Hand-held dynamometry in children with traumatic brain injury (TBI): within-session reliability.	4	HHD in children with TBI vs. normal controls; Matched for age and gender; Four lower limb muscle groups tested twice; n = 24 children (in each arm)	HHD Intra-rater reliability: 0.91 (TBI) -0.99 (controls)
Crompton et al¹²	<i>Dev Med Child Neurol</i> 2007	Hand-held dynamometry for muscle strength measurement in children with cerebral palsy.	4	To investigate reliability of HHD strength testing in lower limb muscles in children with CP; Isometric make tests; n = 23 (age 5 to 14 yrs)	ICC all muscle groups > 0.79; ICC < 0.70 for hip extensors (prone)

(Continued)

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Van der Linden et al¹³	<i>Arch Phys Med Rehabil</i> 2004	Test-Retest repeatability of gluteus maximus strength testing using a fixed digital dynamometer in children with cerebral palsy (CP).	3	Glut max strength in prone was measured in children with CP; HHD used; n = 22 (11 CP vs 11 controls)	ICC: CP: 0.75 to 0.83; controls: 0.76 to 0.85
Taylor et al¹⁴	<i>Arch Phys Med Rehabil</i> 2004	Test-retest reliability of hand-held dynamometric strength testing in young people with cerebral palsy (CP).	4	One rater, HHD used on two occasions; n = 10 (age 10 to 17 yrs)	ICC: (position unknown); Hip flexion: 0.95; Hip abduction: 0.89; Hip extension: 0.88
Position and test type					
Lue et al¹⁵	<i>Phys Ther</i> 2009	Influence Of Testing Position On The Reliability Of Hip Extensor Strength Measured By A Handheld Dynamometer	3	HHD used for break tests in prone (PP) and prone standing position (PSP) (weight bearing on one limb but flexed at hip and leaning on examining bench); Intra-session n = 47; Inter-rater n = 16	PSP more reliable than PP when examining hip extension; Inter-rater ICC 0.92 vs 0.65 (PSP vs PP)
Seo et al¹⁶	<i>J Sports Sci Med</i> 2012	Reliability of the one-repetition maximum test based on muscle group and gender	4	To examine influence of muscle group and gender on reliability of assessment of one-repetition max; Upper and lower limb muscles tested; n = 30 (age 18 to 35); Initial testing followed by repeat at 1 wk	Reliable regardless of muscle; group location ICC >0.91; One rep. max test is reliable for change in muscle strength

References

- Poulsen E, Christensen HW, Penny JØ, et al.** Reproducibility of range of motion and muscle strength measurements in patients with hip osteoarthritis - an inter-rater study. *BMC Musculoskelet Disord* 2012;13:242.
- Thorborg K, Serner A, Petersen J, et al.** Hip adduction and abduction strength profiles in elite soccer players: implications for clinical evaluation of hip adductor muscle recovery after injury. *Am J Sports Med* 2011;39:121-126.
- Wang CY, Olson SL, Protas EJ.** Test-retest strength reliability: hand-held dynamometry in community-dwelling elderly fallers. *Arch Phys Med Rehabil* 2002;83:811-815.
- Pua YH, Wrigley TV, Cowan SM, Bennell KL.** Intrarater test-retest reliability of hip range of motion and hip muscle strength measurements in persons with hip osteoarthritis. *Arch Phys Med Rehabil* 2008;89:1146-1154.
- Sherrington C, Lord SR.** Reliability of simple portable tests of physical performance in older people after hip fracture. *Clin Rehabil* 2005;19:496-504.
- Arokoski MH, Arokoski JP, Haara M, et al.** Hip muscle strength and muscle cross sectional area in men with and without hip osteoarthritis. *J Rheumatol* 2002;29:2185-2195.
- Meyer C, Corten K, Wesseling M, et al.** Test-Retest Reliability of Innovated Strength Tests for Hip Muscles. *PLoS One* 2010;8:e81149.
- Schmidt J, Iverson J, Brown S, Thompson PA.** Comparative reliability of the make and break tests for hip abduction assessment. *Physiother Theory Pract* 2013;29:648-657.
- Lee SPPC, Powers C.** Description of a weight-bearing method to assess hip abductor and external rotator muscle performance. *J Orthop Sports Phys Ther* 2013;43:392-397.
- Hébert LJ, Maltais DB, Lepage C, et al.** Isometric muscle strength in youth assessed by hand-held dynamometry: a feasibility, reliability, and validity study. *Pediatr Phys Ther* 2011;23:289-299.
- Katz-Leurer M, Rottem H, Meyer S.** Hand-held dynamometry in children with traumatic brain injury: within-session reliability. *Pediatr Phys Ther* 2008;20:259-263.
- Crompton J, Galea MP, Phillips B.** Hand-held dynamometry for muscle strength measurement in children with cerebral palsy. *Dev Med Child Neurol* 2007;49:106-111.
- van der Linden ML, Aitchison AM, Hazlewood ME, Hillman SJ, Robb JE.** Test-Retest repeatability of gluteus maximus strength testing using a fixed digital dynamometer in children with cerebral palsy. *Arch Phys Med Rehabil* 2004;85:2058-2063.
- Taylor NF, Dodd KJ, Graham HK.** Test-retest reliability of hand-held dynamometric strength testing in young people with cerebral palsy. *Arch Phys Med Rehabil* 2004;85:77-80.
- Lue YJ, Hsieh CL, Liu MF, et al.** Influence of testing position on the reliability of hip extensor strength measured by a handheld dynamometer. *Kaohsiung J Med Sci* 2009;25:126-132.
- Seo DI, Kim E, Fahs CA, et al.** Reliability of the one-repetition maximum test based on muscle group and gender. *J Sports Sci Med* 2012;11:221-225.