Peak Force preferred test positions

Which test should you use? That's a simple question but a bit of a complicated answer, I'm afraid. We have copies of hundreds of peer-reviewed HHD research articles. The variability in test positions, equipment and protocols is simply staggering.

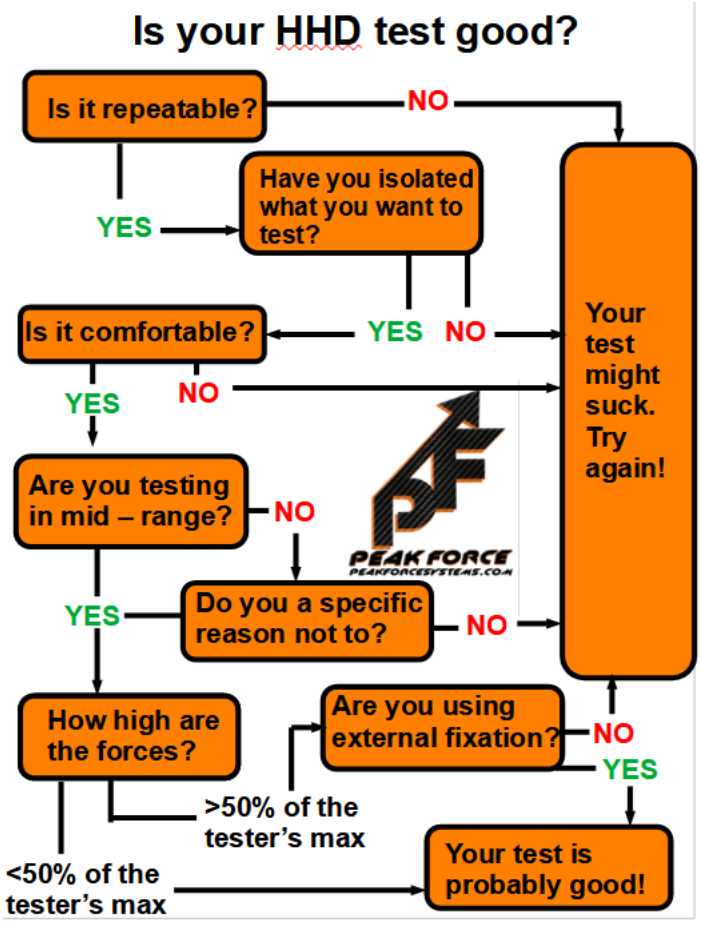
We have scoured the research (and will continue to do so) looking for every bit of information we can find. This, combined with years of clinical practice testing real patients with HHDs, have informed this 'preferred' list.

As far as the normative data is concerned, well, more research is needed. Some of these sample sizes are rather small and may not apply to your population. You can always pull up our full database at www.peakforcesystems.com to quickly search for a study that has a population similar to yours. We've done our best to synthesize the data to make it useful for you, the clinician. It's far from perfect but we think it will give you some guidance whether you've been using dynamometers for years or this is your first time.

This list is FAR from all the tests that are possible with HHDs. Want to make one up? Great! We recommend using this guide to ensure you arrive at a quality test. Just because you use a good tool doesn't mean your test is good.

If you have a question, concern or suggestion, feel free to reach out to us @PeakForceSystems on instagram or Jacob@PeakForceSystems.com.

#testdontguess



Preferred Positions

Shoulder

Abduction	90* abduction
Flexion	90* flexion
Flexion	Full Flexion
IR	0*, elbow bent
IR 90/90	90/90
IR 90/0	90/0
ER	0*, elbow bent
ER 90/90	90/90
ER 90/0	90/0
Horizontal abduction	Seated, 90* flexion
Extension	0*, elbow bent
Extension	90* flexion, elbow bent
Extension	180* flexion, elbow straight
Scapular elevation	Seated, HHD on acromion

Elbow

Flexion	Supine 90* flexion
Extension	Supine 90* flexion

Wrist

Flexion	Seated, 0*
Extension	Seated, 0*

Hip

Flexion	Seated, 90* flexion
Extension	Prone, 45* hip flexion
Abduction	0*, long lever
Abduction	0*, short lever
Adduction	0*, long lever
Adduction	0*, short lever
IR	Seated, 90/90
IR	Prone 0/90
ER	Seated, 90/90
ER	Prone 0/90

Knee

Extension	Seated, 90*
Flexion	Seated, 90*

Ankle

PF	Seated, 0*
DF	Supine/Long sit
Eversion	Supine/Long sit
Inversion	Supine/Long sit

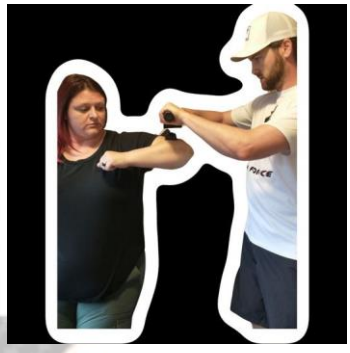
Cervical

Flexion	Seated, 0*
Extension	Seated, 0*
Sidebend	Seated, 0*

Shoulder Abduction

Position: Patient seated with feet flat on the ground. Arm abducted to 90*, elbow bent.

HHD placement: Just proximal to elbow



Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
115.5	11.8	26.0

19.% of bodyweight

Clinical Applications: Any upper quarter pathology

Citations:

Douma, R. K. W., Soer, R., Krijnen, W. P., Reneman, M., & van der Schans, C. P. (2014). Reference values for isometric muscle force among workers for the Netherlands: A comparison of reference values. BMC Sports Science, Medicine and Rehabilitation, 6(1). https://doi.org/10.1186/2052-1847-6-10

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Cheung, A. T. H., Ma, A. W. W., Fong, S. S. M., Chung, L. M. Y., Bae, Y. H., Liu, K. P. Y., Kam, K. W. K., & Chung, J. W. Y. (2018). A comparison of shoulder muscular performance and lean mass between elite and recreational swimmers Implications for talent identification and development. Medicine (United States), 97(47). https://doi.org/10.1097/MD.0000000000013258

Escobar, R. G., Munoz, K. T., Dominguez, A., Banados, P., & Bravo, M. J. (2017). Maximal isometric muscle strength values obtained By hand-held dynamometry in children between 6 and 15 years of age. Muscle and Nerve, 55(1), 16–22. https://doi.org/10.1002/mus.25180

Katoh, M. (n.d.-b). *Test-retest reliability of isometric shoulder muscle strength measurement with a handheld dynamometer and belt*.

Shoulder Flexion (90*)

Position: Patient seated with feet flat on the ground. Arm flexed to 90*, elbow bent.

HHD placement: Just proximal to elbow

Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
119.5	12.2	26.9

16.7% of bodyweight

Clinical Applications: Any upper quarter pathology

Citations:

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

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Escobar, R. G., Munoz, K. T., Dominguez, A., Banados, P., & Bravo, M. J. (2017). Maximal isometric muscle strength values obtained By hand-held dynamometry in children between 6 and 15 years of age. Muscle and Nerve, 55(1), 16–22. https://doi.org/10.1002/mus.25180

Huberman, C., Scales, M., & Vallabhajosula, S. (2020). Shoulder Range of Motion and Strength Characteristics in Circus Acrobats. Medical Problems of Performing Artists, 35(3), 145–152. https://doi.org/10.21091/mppa.2020.3025

Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Shoulder Flexion (180*)

Position: Patient seated with feet flat on the ground. Arm flexed to full, elbow straight.

HHD placement: Just proximal to wrist

Force direction (of tester): Anterior

Norms:

Newtons	Kg	Lb
72.3	7.4	16.3

12.0% of bodyweight

Clinical Applications: Overhead athletes

Citations:

McLaine, S. J., Ginn, K. A., Kitic, C. M., Fell, J. W., & Bird, M. L. (2016). The Reliability of Strength Tests Performed In Elevated Shoulder Positions Using a Handheld Dynamometer. Journal of Sport Rehabilitation, Technical Report. https://doi.org/10.1123/jsr.2015-0034

Shoulder IR (neutral)

Position: Patient seated with feet flat on the ground. Elbow bent to 90*

HHD placement: Just proximal to wrist

Force direction (of tester): Lateral

Norms:

Newtons	Kg	Lb
175.5	17.9	39.4

23.7% of bodyweight

Clinical Applications: Any upper quarter pathology

Citations:

McKay, M., Baldwin, J., Ferreira, P., Simic, M., & Vanicek, J. (2016). *Normative reference values for strength and flexibility of 1,000 children and adults*.

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

Roach, C. J., Cameron, K. L., Westrick, R. B., Posner, M. A., & Owens, B. D. (2013). Rotator cuff weakness is not a risk factor for first-time anterior glenohumeral instability. Orthopaedic Journal of Sports Medicine, 1(1), 1–6. https://doi.org/10.1177/2325967113489097

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Westrick, R. B., Duffey, M. L., Cameron, K. L., Gerber, J. P., & Owens, B. D. (2013). Isometric Shoulder Strength Reference Values for Physically Active Collegiate Males and Females. Sports Health, 5(1), 17–21. https://doi.org/10.1177/1941738112456280

Shoulder IR (90/90)

Position: Seated, shoulder abducted to 90*. Elbow flexed to 90*, shoulder ER 90*

HHD placement: Just proximal to wrist

Force direction (of tester): Posterior

Norms:

Newtons	Kg	Lb
95.2	9.7	21.4

14.0% of bodyweight

Clinical Applications: Overhead athletes

Citations:

Awatani, T., Morikita, I., Shinohara, J., Mori, S., Nariai, M., Tatsumi, Y., Nagata, A., & Koshiba, H. (n.d.). *Intra-and inter-rater reliability of isometric shoulder extensor and internal rotator strength measurements performed using a hand-held dynamometer*.

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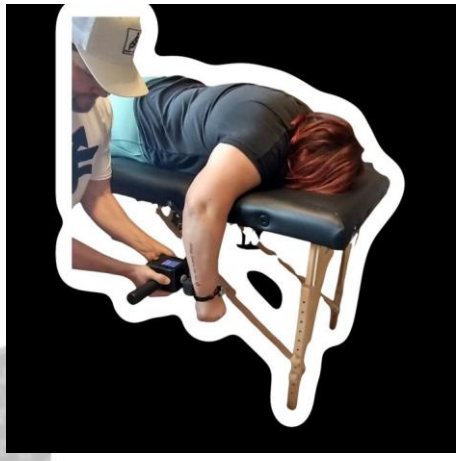
Oliver, G. D., Downs, J. L., Barbosa, G. M., & Camargo, P. R. (2020). DESCRIPTIVE PROFILE OF SHOULDER RANGE OF MOTION AND STRENGTH IN YOUTH ATHLETES PARTICIPATING IN OVERHEAD SPORTS. International Journal of Sports Physical Therapy, 15(6), 1090–1098. https://doi.org/10.26603/ijspt20201090

Shoulder IR (90/0)

Position: Prone, shoulder abducted to 90*. Elbow flexed to 90*, shoulder neutral (forearm vertical)



HHD placement: Just proximal to wrist

Force direction (of tester): Superior

Norms:

Newtons	Kg	Lb
154.4	15.7	34.7

24.2% of bodyweight

Clinical Applications: Any shoulder pathology (RC tears, impingement, instability, etc.)

Citations:

Furness, J., Schram, B., Cottman-Fields, T., Solia, B., & Secomb, J. (2018). Profiling Shoulder Strength in Competitive Surfers. Sports, 6(2), 52. https://doi.org/10.3390/sports6020052

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Maestroni, L., Marelli, M., Gritti, M., Civera, F., & Rabey, M. (2020). External rotator strength deficits in non-athletic people with rotator cuff related shoulder pain are not associated with pain intensity or disability levels. Musculoskeletal Science and Practice, 48. https://doi.org/10.1016/j.msksp.2020.102156

Conceição, A. N. A., Parraca, J., Marinho, D., Costa, M., Louro, H., Silva, A., & Batalha, N. (2018). Assessment of isometric strength of the shoulder rotators in swimmers using a handheld dynamometer: A reliability study. Acta of Bioengineering and Biomechanics, 20(4), 113–119. https://doi.org/10.5277/ABB-01237-2018-02

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Shoulder ER (neutral)

Position: Seated, feet flat on floor, elbow flexed to 90*, elbow by side.

HHD placement: Just proximal to wrist

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
123.4	12.6	27.7

17.7% of bodyweight

Clinical Applications: Any shoulder pathology (RC tears, impingement, instability, etc.)

Citations:

McKay, M., Baldwin, J., Ferreira, P., Simic, M., & Vanicek, J. (2016). *Normative reference values for strength and flexibility of 1,000 children and adults*.

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

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Uga, D., & Nakazawa, R. (n.d.). *Strength and muscle activity of shoulder external rotation of subjects with and without scapular dyskinesis*.

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Nakaji, R. M., Ellenbecker, T. S., McClenahan, K. M., Roberts, L. M., Perez, C., & Dickenson, S. B. (2021). Descriptive Strength and Range of Motion in Youth Baseball Players. International Journal of Sports Physical Therapy. https://doi.org/10.26603/001c.18815

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Westrick, R. B., Duffey, M. L., Cameron, K. L., Gerber, J. P., & Owens, B. D. (2013). Isometric Shoulder Strength Reference Values for Physically Active Collegiate Males and Females. Sports Health, 5(1), 17–21. https://doi.org/10.1177/1941738112456280

Shoulder ER (90/90)

Position: Prone, shoulder abducted to 90*, ER to 90*, elbow flexed to 90*

HHD placement: Just proximal to wrist

Force direction (of tester): Down, anterior

Norms:

Newtons	Kg	Lb
91.8	9.4	20.6

14.3% of bodyweight

Clinical Applications: Any shoulder pathology (RC tears, impingement, instability, etc.)

Citations:

Oliver, G. D., Downs, J. L., Barbosa, G. M., & Camargo, P. R. (2020). DESCRIPTIVE PROFILE OF SHOULDER RANGE OF MOTION AND STRENGTH IN YOUTH ATHLETES PARTICIPATING IN OVERHEAD SPORTS. International Journal of Sports Physical Therapy, 15(6), 1090–1098. https://doi.org/10.26603/ijspt20201090

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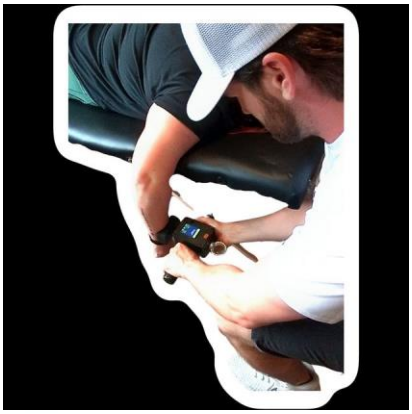
Shoulder ER (90/0)

Position: Prone, shoulder abducted to 90*, neutral rotation (forearm vertical), eblow flexed to 90*

HHD placement: Just proximal to wrist



Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
121.0	12.3	27.2

20.2% of bodyweight

Clinical Applications: Overhead athletes

Citations:

Furness, J., Schram, B., Cottman-Fields, T., Solia, B., & Secomb, J. (2018). Profiling Shoulder Strength in Competitive Surfers. Sports, 6(2), 52. https://doi.org/10.3390/sports6020052

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Liaghat, B., Bencke, J., Zebis, M. K., Sørensen, H., Myklebust, G., Wedderkopp, N., Lind, M., & Møller, M. (2020). Shoulder Rotation Strength Changes From Preseason to Midseason: A Cohort Study of 292 Youth Elite Handball Players Without Shoulder Problems. Journal of Orthopaedic & Sports Physical Therapy, 50(7), 381–387. https://doi.org/10.2519/jospt.2020.9183

Fieseler, G., Molitor, T., Irlenbusch, L., Delank, K. S., Laudner, K. G., Hermassi, S., & Schwesig, R. (2015). Intrarater reliability of goniometry and hand-held dynamometry for shoulder and elbow examinations in female team handball athletes and asymptomatic volunteers. Archives of Orthopaedic and Trauma Surgery, 135(12), 1719–1726. https://doi.org/10.1007/s00402-015-2331-6

Shoulder Horizontal Abduction (T)

Position: Seated, Shoulder flexed to 90*

While commonly tested in prone, in full horizontal abduction for MMT's, we rarely advocate for testing at full end range due to the reduced force in this position as described by the length-tension relationship

HHD placement: Just proximal to elbow

Force direction (of tester): Medial

Norms:

No data

Clinical Applications: Any upper quarter pathology

Citations:

Shoulder Extension (0*)

Position: Seated, feet on floor, shoulder by side, elbow bent

HHD placement: Just proximal to elbow

Force direction (of tester): Anterior

Norms:

Newtons	Kg	Lb
127.9	13.0	28.8

21.7% of bodyweight

Clinical Applications: All upper quarter pathologies

Citations:

Cheung, A. T. H., Ma, A. W. W., Fong, S. S. M., Chung, L. M. Y., Bae, Y. H., Liu, K. P. Y., Kam, K. W. K., & Chung, J. W. Y. (2018). A comparison of shoulder muscular performance and lean mass between elite and recreational swimmers Implications for talent identification and development. Medicine (United States), 97(47). https://doi.org/10.1097/MD.0000000000013258

Katoh, M. (n.d.-b). *Test-retest reliability of isometric shoulder muscle strength measurement with a handheld dynamometer and belt*.

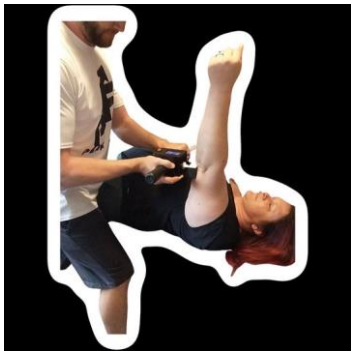
Romero-Franco, N., Fernández-Domínguez, J. C., Montaño-Munuera, J. A., Romero-Franco, J., & Jiménez-Reyes, P. (2019). Validity and reliability of a low-cost dynamometer to assess maximal isometric strength of upper limb: Low cost dynamometry and isometric strength of upper limb. Journal of Sports Sciences, 37(15), 1787–1793. https://doi.org/10.1080/02640414.2019.1594570

Shoulder Extension (90*)

Position: Supine, shoulder flexed to 90*

HHD placement: Just proximal to elbow

Force direction (of tester): Superior



Norms:

Newtons	Kg	Lb
241.3	24.6	54.2

18.5% of bodyweight

Clinical Applications: Swimmers and rowers especially

Citations:

Huberman, C., Scales, M., & Vallabhajosula, S. (2020). Shoulder Range of Motion and Strength Characteristics in Circus Acrobats. Medical Problems of Performing Artists, 35(3), 145–152. https://doi.org/10.21091/mppa.2020.3025

Bohannon, Richard W. (n.d.). Reference Values for Extremity Muscle Strength Obtained by Hand-Held Dynamometry From Adults Aged 20 to 79 Years.

Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Shoulder Extension (180*)

Position: Supine, shoulder flexed to 180*, elbow straight

HHD placement: Just proximal to wrist

Force direction (of tester): Posterior

Norms:

Newtons	Kg	Lb
76.2	7.8	17.1

13.2% of bodyweight

Clinical Applications: Swimmers and rowers especially, overhead athletes, cross country skiers, climbers

McLaine, S. J., Ginn, K. A., Kitic, C. M., Fell, J. W., & Bird, M. L. (2016). The Reliability of Strength Tests Performed In Elevated Shoulder Positions Using a Handheld Dynamometer. Journal of Sport Rehabilitation, Technical Report. https://doi.org/10.1123/jsr.2015-0034

awaTani, T., Mori, S., Shinohara, J., koShiba, hiroya, nariai, M., TaTSuMi, yaSuTaka, nagaTa, akinori, & MorikiTa, ikuhiro. (n.d.). *Same-session and between-day intra-rater reliability of hand-held dynamometer measurements of isometric shoulder extensor strength*.

Awatani, T., Morikita, I., Shinohara, J., Mori, S., Nariai, M., Tatsumi, Y., Nagata, A., & Koshiba, H. (n.d.). *Intra- and inter-rater reliability of isometric shoulder extensor and internal rotator strength measurements performed using a hand-held dynamometer*.

McLaine, S. J., Ginn, K. A., Kitic, C. M., Fell, J. W., & Bird, M. L. (2016). The Reliability of Strength Tests Performed In Elevated Shoulder Positions Using a Handheld Dynamometer. Journal of Sport Rehabilitation, Technical Report. https://doi.org/10.1123/jsr.2015-0034

McLaine, S. J., Ginn, K. A., Kitic, C. M., Fell, J. W., & Bird, M. L. (2016). The Reliability of Strength Tests Performed In Elevated Shoulder Positions Using a Handheld Dynamometer. Journal of Sport Rehabilitation, Technical Report. https://doi.org/10.1123/jsr.2015-0034

Scapular Elevation (Shrug)

Position: Seated, shoulder by side

HHD placement: On acromion

Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
181.8	18.5	40.9

34.3% of bodyweight

*** These norms likely undershoot real capacity. Be prepared to use external fixation for strong patients (seated, with pull straps anchored on floor)***

Clinical applications: Any upper quarter patholgy, especially neck pain

Citations:

Celik, D., Dirican, A., & Baltaci, G. (2012). Intrarater reliability of assessing strength of the shoulder and scapular muscles. Journal of Sport Rehabilitation, Technical Notes 3, 1–5. https://doi.org/10.1123/jsr.2012.tr3

Cools, A. M., Palmans, T., & Johansson, F. R. (2014). Age-related, sport-specific adaptions of the shoulder girdle in elite adolescent tennis players. Journal of Athletic Training, 49(5), 647–653. https://doi.org/10.4085/1062-6050-49.3.02

Hannah, D., Scibek, J., & Carcia, C. (2017). Strength Profiles in Healthy Individuals with and without Scapular Dyskinesis. *IJSPT*, *12*(3), 390–401.

Park, K. N., Jung, D. Y., & Kim, S. H. (2020). Trapezius and serratus anterior muscle strength in violinists with unilateral neck pain. Journal of Back and Musculoskeletal Rehabilitation, 33(4), 631–636. https://doi.org/10.3233/BMR-181147

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Gillet, B., Begon, M., Sevrez, V., Berger-Vachon, C., & Rogowski, I. (2017). Adaptive alterations in shoulder range of motion and strength in young tennis players. Journal of Athletic Training, 52(2), 137–144. https://doi.org/10.4085/1062-6050.52.1.10

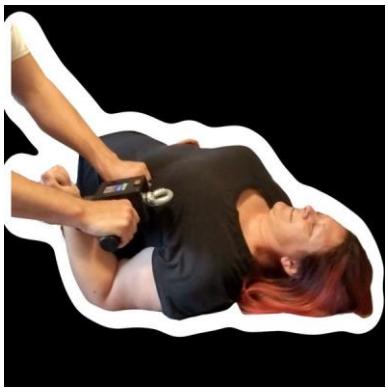
Hannah, D., Scibek, J., & Carcia, C. (2017). Strength Profiles in Healthy Individuals with and without Scapular Dyskinesis. *IJSPT*, *12*(3), 390–401.

Doraisamy, M. A., & Anshul. (2011). Effect of latent myofascial trigger points on strength measurements of the upper trapezius: A case-controlled trial. Physiotherapy Canada, 63(4), 405–409. https://doi.org/10.3138/ptc.2010-27

Elbow Flexion

Position: Supine, shoulder by side, elbow flexed to 90*, wrist supinated.

HHD placement: Just proximal to wrist



Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
174.2	17.8	39.2

26.4% of bodyweight

Clinical applications: Elbow, shoulder pathology. Especially biceps tear.

Citations:

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

West, A. M., Scarborough, D. M., McInnis, K. C., & Oh, L. S. (2019). Strength and Motion in the Shoulder, Elbow, and Hip in Softball Windmill Pitchers. PM and R, 11(12), 1302–1311. https://doi.org/10.1002/pmrj.12135

Tan, A. E. L., Grisbrook, T. L., Minaee, N., & Williams, S. A. (2018). Predicting 1 Repetition Maximum Using Handheld Dynamometry. PM and R, 10(9), 934–941. https://doi.org/10.1016/j.pmrj.2018.02.017

Douma, R. K. W., Soer, R., Krijnen, W. P., Reneman, M., & van der Schans, C. P. (2014). Reference values for isometric muscle force among workers for the Netherlands: A comparison of reference values. BMC Sports Science, Medicine and Rehabilitation, 6(1). https://doi.org/10.1186/2052-1847-6-10

Wikholm, J. B., & Bohannon, R. W. (1991). *Hand-held Dynamometer Measurements: Tester Strength*. www.jospt.org

Daloia, L. M. T., Leonardi-Figueiredo, M. M., Martinez, E. Z., & Mattiello-Sverzut, A. C. (2018). Isometric muscle strength in children and adolescents using Handheld dynamometry: reliability and normative data for the Brazilian population. Brazilian Journal of Physical Therapy, 22(6), 474–483. https://doi.org/10.1016/j.bjpt.2018.04.006

Kim, S.-G., Lim, D.-H., & Cho, Y. H. (n.d.). *Analysis of the reliability of the make test in young adults by using a hand-held dynamometer*.

McKay, M., Baldwin, J., Ferreira, P., Simic, M., & Vanicek, J. (2016). *Normative reference values for strength and flexibility of 1,000 children and adults*.

Escobar, R. G., Munoz, K. T., Dominguez, A., Banados, P., & Bravo, M. J. (2017). Maximal isometric muscle strength values obtained By hand-held dynamometry in children between 6 and 15 years of age. Muscle and Nerve, 55(1), 16–22. https://doi.org/10.1002/mus.25180

Bohannon, Richard W. (n.d.). Reference Values for Extremity Muscle Strength Obtained by Hand-Held Dynamometry From Adults Aged 20 to 79 Years.

Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Elbow Extension

Position: Supine, forearm supinated, arm by side, elbow flexed to 90*, wrist neutral

HHD placement: Just proximal to wrist

Force direction (of tester): Superior

Norms:

Newtons	Kg	Lb
128.7	13.1	28.9

20.2% of bodyweight

Clinical applications: Elbow (UCL, OCD), shoulder pathology. Especially triceps tear.

Citations:

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

Douma, R. K. W., Soer, R., Krijnen, W. P., Reneman, M., & van der Schans, C. P. (2014). Reference values for isometric muscle force among workers for the Netherlands: A comparison of reference values. BMC Sports Science, Medicine and Rehabilitation, 6(1). https://doi.org/10.1186/2052-1847-6-10

Daloia, L. M. T., Leonardi-Figueiredo, M. M., Martinez, E. Z., & Mattiello-Sverzut, A. C. (2018). Isometric muscle strength in children and adolescents using Handheld dynamometry: reliability and normative data for the Brazilian population. Brazilian Journal of Physical Therapy, 22(6), 474–483. https://doi.org/10.1016/j.bjpt.2018.04.006

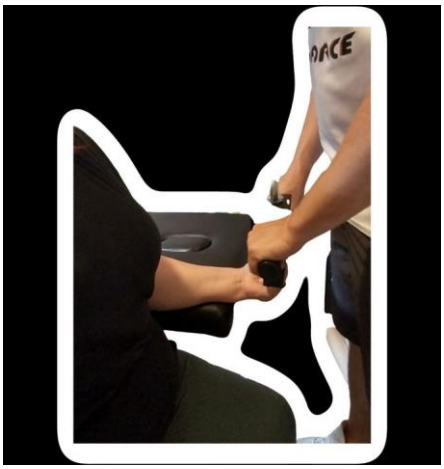
McKay, M., Baldwin, J., Ferreira, P., Simic, M., & Vanicek, J. (2016). *Normative reference values for strength and flexibility of 1,000 children and adults*.

Escobar, R. G., Munoz, K. T., Dominguez, A., Banados, P., & Bravo, M. J. (2017). Maximal isometric muscle strength values obtained By hand-held dynamometry in children between 6 and 15 years of age. Muscle and Nerve, 55(1), 16–22. https://doi.org/10.1002/mus.25180

Bohannon, Richard W. (n.d.). Reference Values for Extremity Muscle Strength Obtained by Hand-Held Dynamometry From Adults Aged 20 to 79 Years.

Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Wrist Flexion



Position: Seated, forearm supported, wrist supinated

HHD placement: Distal metacarpal heads

Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
117.4	12.0	26.4

14.3% of bodyweight

Clinical applications: Tennis elbow, golf elbow, rock climbers, throwers, UCL injuries

Citations:

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

Lucado, A., Fraher, L., Patel, H., & Munck, G. (2019). Comparison of portable handheld versus fixed isokinetic dynamometers in measuring strength of the wrist and forearm. Physiotherapy Theory and Practice, 35(7), 677–685. https://doi.org/10.1080/09593985.2018.1455248

Romero-Franco, N., Fernández-Domínguez, J. C., Montaño-Munuera, J. A., Romero-Franco, J., & Jiménez-Reyes, P. (2019). Validity and reliability of a low-cost dynamometer to assess maximal isometric strength of upper limb: Low cost dynamometry and isometric strength of upper limb. Journal of Sports Sciences, 37(15), 1787–1793. https://doi.org/10.1080/02640414.2019.1594570

Wrist Extension

Position: Seated, forearm supported, wrist pronated

HHD placement: Distal metacarpal heads

Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
120.5	12.3	27.1

15.9% of bodyweight

Clinical applications: Tennis elbow, golf elbow, rock climbers, throwers, UCL injuries

Citations:

van Harlinger, W., Blalock, L., & Merritt, J. L. (2015). Upper Limb Strength: Study Providing Normative Data for aClinical Handheld Dynamometer. PM and R, 7(2), 135–140. https://doi.org/10.1016/j.pmrj.2014.09.007

Lucado, A., Fraher, L., Patel, H., & Munck, G. (2019). Comparison of portable handheld versus fixed isokinetic dynamometers in measuring strength of the wrist and forearm. Physiotherapy Theory and Practice, 35(7), 677–685. https://doi.org/10.1080/09593985.2018.1455248

Romero-Franco, N., Fernández-Domínguez, J. C., Montaño-Munuera, J. A., Romero-Franco, J., & Jiménez-Reyes, P. (2019). Validity and reliability of a low-cost dynamometer to assess maximal isometric strength of upper limb: Low cost dynamometry and isometric strength of upper limb. Journal of Sports Sciences, 37(15), 1787–1793. https://doi.org/10.1080/02640414.2019.1594570

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Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Hip Flexion

Position: Seated, on plinth, hands by sides

HHD placement: Just proximal to knee

Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
183.9	18.7	41.3

26.9% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA

Citations:

Arnold, C. M., Warkentin, K. D., Chilibeck, P. D., & Magnus, C. R. A. (n.d.). *THE RELIABILITY AND VALIDITY OF HANDHELD DYNAMOMETRY FOR THE MEASUREMENT OF LOWER-EXTREMITY MUSCLE STRENGTH IN OLDER ADULTS*. www.nsca-jscr.org

Mentiplay, B. F., Perraton, L. G., Bower, K. J., Adair, B., Pua, Y. H., Williams, G. P., McGaw, R., & Clark, R. A. (2015). Assessment of lower limb muscle strength and power using hand-held and fixed dynamometry: A reliability and validity study. PLoS ONE, 10(10). https://doi.org/10.1371/journal.pone.0140822

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de Ridder, R., Witvrouw, E., Dolphens, M., Roosen, P., & van Ginckel, A. (2017). Hip Strength as an Intrinsic Risk Factor for Lateral Ankle Sprains in Youth Soccer Players. In American Journal of Sports Medicine (Vol. 45, Issue 2, pp. 410–416). SAGE Publications Inc. https://doi.org/10.1177/0363546516672650

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Thorborg, Kristian, Bandholm, T., & Hölmich, P. (2013). Hip- and knee-strength assessments using a hand-held dynamometer with external belt-fixation are inter-tester reliable. Knee Surgery, Sports Traumatology, Arthroscopy, 21(3), 550–555. https://doi.org/10.1007/s00167-012-2115-2

Bazett-Jones, D. M., Cobb, S. C., Joshi, M. N., Cashin, S. E., & Earl, J. E. (2011). Normalizing hip muscle strength: Establishing body-size-independent measurements. Archives of Physical Medicine and Rehabilitation, 92(1), 76–82. https://doi.org/10.1016/j.apmr.2010.08.020

Florencio, L. L., Martins, J., da Silva, M. R. B., da Silva, J. R., Bellizzi, G. L., & Bevilaqua-Grossi, D. (2019). Knee and hip strength measurements obtained by a hand-held dynamometer stabilized by a belt and an examiner demonstrate parallel reliability but not agreement. Physical Therapy in Sport, 38, 115–122. https://doi.org/10.1016/j.ptsp.2019.04.011

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Pasco, J. A., Holloway, K. L., Brennan-Olsen, S. L., Moloney, D. J., & Kotowicz, M. A. (2015). Muscle strength and areal bone mineral density at the hip in women: A cross-sectional study Epidemiology of musculoskeletal disorders. BMC Musculoskeletal Disorders, 16(1). https://doi.org/10.1186/s12891-015-0586-2

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Hirunyaphinun, B., Taweetanalarp, S., & Tantisuwat, A. (2019). Relationships between lower extremity strength and the multi-directional reach test in children aged 7 to 12 years. Hong Kong Physiotherapy Journal, 39(2), 143–150. https://doi.org/10.1142/S1013702519500136

Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Hip Extension

Position: Prone, edge of table, hip in 45* of hip flexion

Commonly tested in prone at 0* of hip flexion, this is too close to end range hip extension to adequately assess hip extension strength as described by the length-tension relationship. See more from this study: Bazett-Jones DM, Squier K. Measurement properties of hip strength measured by handheld dynamometry: Reliability and validity across the range of motion. *Physical Therapy in Sport*. 2020;42:100-106. doi:10.1016/j.ptsp.2020.01.005

HHD placement: Just proximal to knee

Force direction (of tester): Perpendicular to thigh (anterior/superior)

Norms:

Newtons	Kg	Lb
256.6	26.2	57.7

45.5% of bodyweight

This is a strong movement. Consider using long lever (HHD at ankle) or external fixation (straps around plinth) for stronger subjects

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA

Citations:

Martins, J., da Silva, J. R., da Silva, M. R. B., & Bevilaqua-Grossi, D. (2017). Reliability and validity of the belt-stabilized handheld dynamometer in hip-and knee-strength tests. Journal of Athletic Training, 52(9), 809–819. https://doi.org/10.4085/1062-6050-52.6.04

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Alsufiany, M. B., Lohman, E. B., Daher, N. S., Gang, G. R., Shallan, A. I., & Jaber, H. M. (2020). Non-specific chronic low back pain and physical activity: A comparison of postural control and hip muscle isometric strength: A cross-sectional study. Medicine, 99(5), e18544. https://doi.org/10.1097/MD.0000000000018544

Mulligan, E. P., & DeVahl, J. (2020). CAN PROXIMAL HIP STRENGTH AND DYNAMIC CONTROL DIFFERENTIATE FUNCTIONAL ANKLE STABILITY CLASSIFICATIONS? International Journal of Sports Physical Therapy, 15(6), 1061–1072. https://doi.org/10.26603/ijspt20201061

Hip Abduction (short lever)

Position: Supine, contralateral knee bent, foot flat on plinth, both hands holding edges of plinth

HHD placement: Just proximal to knee

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
194.2	19.8	38.8

32.3% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR

Citations:

Hannon, J., Wang-Price, S., Goto, S., Garrison, J. C., & Bothwell, J. M. (2017). Do Muscle Strength Deficits of the Uninvolved Hip and Knee Exist in Young Athletes Before Anterior Cruciate Ligament Reconstruction? Orthopaedic Journal of Sports Medicine, 5(1). https://doi.org/10.1177/2325967116683941

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Arnold, C. M., Warkentin, K. D., Chilibeck, P. D., & Magnus, C. R. A. (n.d.). *THE RELIABILITY AND VALIDITY OF HANDHELD DYNAMOMETRY FOR THE MEASUREMENT OF LOWER-EXTREMITY MUSCLE STRENGTH IN OLDER ADULTS*. www.nsca-jscr.org

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Hip Abduction (long lever)

Position: Supine, contralateral knee bent, foot flat on plinth, both hands holding edges of plinth

HHD placement: Just proximal to ankle

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
148.3	15.1	33.3

22.9% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR

Citations:

Olsen, B., Freijomil, N., Csonka, J., Moore, T., Killelea, C., Faherty, M. S., & Sell, T. C. (2021). The Relationship Between Hip Strength and Postural Stability in Collegiate Athletes Who Participate in Lower Extremity Dominant Sports. International Journal of Sports Physical Therapy. https://doi.org/10.26603/001c.18817

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Moradi, Z., Akbari, M., Ansari, N. N., Emrani, A., & Mohammadi, P. (2014). Strength of hip muscle groups in sedentary women with patellofemoral pain syndrome. Journal of Back and Musculoskeletal Rehabilitation, 27(3), 299–306. https://doi.org/10.3233/BMR-130447

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Thorborg, K., Bandholm, T., Schick, M., Jensen, J., & Hölmich, P. (2013). Hip strength assessment using handheld dynamometry is subject to intertester bias when testers are of different sex and strength. Scandinavian Journal of Medicine and Science in Sports, 23(4), 487–493. https://doi.org/10.1111/j.1600-0838.2011.01405.x

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Ishøi, L., Hölmich, P., & Thorborg, K. (2019). MEASURES OF HIP MUSCLE STRENGTH AND RATE OF FORCE DEVELOPMENT USING A FIXATED HANDHELD DYNAMOMETER: INTRA-TESTER INTRA-DAY RELIABILITY OF A CLINICAL SET-UP. International Journal of Sports Physical Therapy, 14(5), 715–723. https://doi.org/10.26603/ijspt20190715

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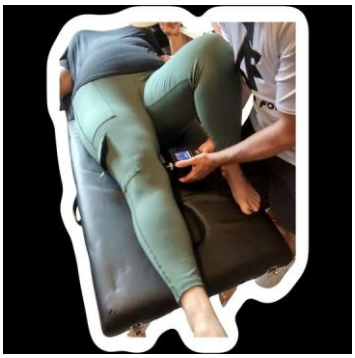
Hip Adduction (short lever)

Position: Supine, contralateral knee bent, foot flat on plinth, both hands holding edges of plinth



HHD placement: Just proximal to knee

Force direction (of tester): Lateral

Norms:

Newtons	Kg	Lb
159.1	16.2	35.8

33.9% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR, athletic pubalgia, adductor strains/avulsions

Citations:

Florencio, L. L., Martins, J., da Silva, M. R. B., da Silva, J. R., Bellizzi, G. L., & Bevilaqua-Grossi, D. (2019). Knee and hip strength measurements obtained by a hand-held dynamometer stabilized by a belt and an examiner demonstrate parallel reliability but not agreement. Physical Therapy in Sport, 38, 115–122. https://doi.org/10.1016/j.ptsp.2019.04.011

Bazett-Jones, D. M., Cobb, S. C., Joshi, M. N., Cashin, S. E., & Earl, J. E. (2011). Normalizing hip muscle strength: Establishing body-size-independent measurements. Archives of Physical Medicine and Rehabilitation, 92(1), 76–82. https://doi.org/10.1016/j.apmr.2010.08.020

Hirunyaphinun, B., Taweetanalarp, S., & Tantisuwat, A. (2019). Relationships between lower extremity strength and the multi-directional reach test in children aged 7 to 12 years. Hong Kong Physiotherapy Journal, 39(2), 143–150. https://doi.org/10.1142/S1013702519500136

de Ridder, R., Witvrouw, E., Dolphens, M., Roosen, P., & van Ginckel, A. (2017). Hip Strength as an Intrinsic Risk Factor for Lateral Ankle Sprains in Youth Soccer Players. In American Journal of Sports Medicine (Vol. 45, Issue 2, pp. 410–416). SAGE Publications Inc. https://doi.org/10.1177/0363546516672650

Hip Adduction (long lever)

Position: Supine, contralateral knee bent, foot flat on plinth, both hands holding edges of plinth

HHD placement: Just proximal to ankle

Force direction (of tester): Lateral

Norms:

Newtons	Kg	Lb
148.9	15.2	33.5

20.7% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR, athletic pubalgia, adductor strains/avulsions

Citations:

Olsen, B., Freijomil, N., Csonka, J., Moore, T., Killelea, C., Faherty, M. S., & Sell, T. C. (2021). The Relationship Between Hip Strength and Postural Stability in Collegiate Athletes Who Participate in Lower Extremity Dominant Sports. International Journal of Sports Physical Therapy. https://doi.org/10.26603/001c.18817

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Hip IR (seated)

Position: Seated, hands on plinth, trunk upright, hip and knee flexed to 90*

HHD placement: Just proximal to ankle

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
133.7	13.6	30.1

15.5% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR, athletic pubalgia, adductor strains/avulsions

Citations:

Alvarenga, G., Kiyomoto, H. D., Martinez, E. C., Polesello, G., & Alves, V. L. dos S. (2019). Normative isometric hip muscle force values assessed by a manual dynamometer. Acta Ortopedica Brasileira, 27(2), 124–128. https://doi.org/10.1590/1413-785220192702202596

McKay, M., Baldwin, J., Ferreira, P., Simic, M., & Vanicek, J. (2016). *Normative reference values for strength and flexibility of 1,000 children and adults*.

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Bloom, N., & Cornbleet, S. L. (2014). Hip rotator strength in healthy young adults measured in hip flexion and extension by using a hand-held dynamometer. PM and R, 6(12), 1137–1142. https://doi.org/10.1016/j.pmrj.2014.06.002

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Hip IR (prone)

Position: Prone, knee bent to 90*

HHD placement: Just proximal to ankle

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
118.0	12.0	26.5

16.5% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR, athletic pubalgia, adductor strains/avulsions

Citations:

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Hip ER (seated)

Position: Seated, hands on plinth, trunk upright, hip and knee flexed to 90*

HHD placement: Just proximal to ankle

Force direction (of tester): Lateral

Norms:

Newtons	Kg	Lb
113.0	11.5	25.4

17.0% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR, athletic pubalgia, adductor strains/avulsions

Citations:

Alvarenga, G., Kiyomoto, H. D., Martinez, E. C., Polesello, G., & Alves, V. L. dos S. (2019). Normative isometric hip muscle force values assessed by a manual dynamometer. Acta Ortopedica Brasileira, 27(2), 124–128. https://doi.org/10.1590/1413-785220192702202596

McKay, M., Baldwin, J., Ferreira, P., Simic, M., & Vanicek, J. (2016). *Normative reference values for strength and flexibility of 1,000 children and adults*.

Harding, J. L., Picha, K. J., & Bliven, K. C. H. (2018). Pitch volume and glenohumeral and hip motion and strength in youth baseball pitchers. Journal of Athletic Training, 53(1), 60–65. https://doi.org/10.4085/1062-6050-323-16

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Almeida, G. P. L., Rodrigues, H. L. D. N., de Freitas, B. W., & de Paula Lima, P. O. (2017). Reliability and validity of the hip stability isometric test (HipSIT): A new method to assess hip posterolateral muscle strength. Journal of Orthopaedic and Sports Physical Therapy, 47(12), 906–913. https://doi.org/10.2519/jospt.2017.7274

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Byrne, A., Lodge, C., & Wallace, J. (2020). Intrarater Test-Retest Reliability of Hip Abduction, Internal Rotation, and External Rotation Strength Measurements in a Healthy Cohort Using a Handheld Dynamometer and a Portable Stabilization Device: A Pilot Study. Archives of Rehabilitation Research and Clinical Translation, 2(2), 100050. https://doi.org/10.1016/j.arrct.2020.100050

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Hip ER (prone)

Position: Prone, knee bent to 90*

HHD placement: Just proximal to ankle

Force direction (of tester): Lateral

Norms:

Newtons	Kg	Lb
119.6	12.2	26.9

17.1% of bodyweight

Clinical applications: Hip apophysitis, Hip flexor strain, low back pain, FAI, trochanteric bursitis, THA, PFPS, SIJ dysfunction, ACLR, athletic pubalgia, adductor strains/avulsions

Citations:

Olsen, B., Freijomil, N., Csonka, J., Moore, T., Killelea, C., Faherty, M. S., & Sell, T. C. (2021). The Relationship Between Hip Strength and Postural Stability in Collegiate Athletes Who Participate in Lower Extremity Dominant Sports. International Journal of Sports Physical Therapy. https://doi.org/10.26603/001c.18817

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Hannon, J. P., Wang-Price, S., Garrison, J. C., Goto, S., Bothwell, J. M., & Bush, C. A. (2019). Normalized Hip and Knee Strength in Two Age Groups of Adolescent Female Soccer Players. www.nsca.com

Moradi, Z., Akbari, M., Ansari, N. N., Emrani, A., & Mohammadi, P. (2014). Strength of hip muscle groups in sedentary women with patellofemoral pain syndrome. Journal of Back and Musculoskeletal Rehabilitation, 27(3), 299–306. https://doi.org/10.3233/BMR-130447

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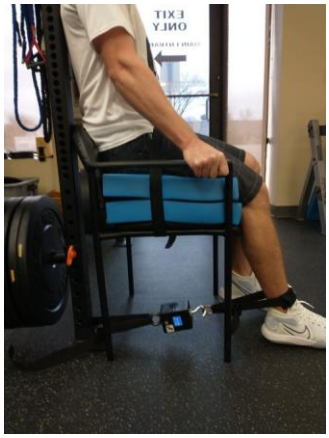
Knee extension

Position: Seated on plinth/box/elevated chair, proximal thigh strapped to pinth (important for strong subjects!), hands on plinth. Should use pull external fixation in almost all cases (except pediatric/fresh post op). Detailed video, instructions can be found at peakforcesystems.com.



HHD placement: Just proximal to ankle

Force direction (of tester): Posterior

Norms:

Newtons	Kg	Lb
254.8	25.1	55.3

52.8% of bodyweight

Clinical applications: PFPS, ACLR, TKA, any knee pathology

Citations:

Peek, K., Gatherer, D., Bennett, K. J. M., Fransen, J., & Watsford, M. (2018). Muscle strength characteristics of the hamstrings and quadriceps in players from a high-level youth football (soccer) Academy. Research in Sports Medicine, 26(3), 276–288. https://doi.org/10.1080/15438627.2018.1447475

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Katoh, M., & Isozaki, K. (n.d.). Reliability of Isometric Knee Extension Muscle Strength Measurements of Healthy Elderly Subjects Made with a Hand-held Dynamometer and a Belt.

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Tan, A. E. L., Grisbrook, T. L., Minaee, N., & Williams, S. A. (2018). Predicting 1 Repetition Maximum Using Handheld Dynamometry. PM and R, 10(9), 934–941. https://doi.org/10.1016/j.pmrj.2018.02.017

Bohannon, R. W., Kindig, J., Sabo, G., Duni, A. E., & Cram, P. (2012). Isometric knee extension force measured using a handheld dynamometer with and without belt-stabilization. Physiotherapy Theory and Practice, 28(7), 562–568. https://doi.org/10.3109/09593985.2011.640385

Knee flexion

Position: Seated on plinth/box/elevated chair, distal thigh strapped to pinth (important for strong subjects!), hands on plinth. Should use pull external fixation in almost all cases (except pediatric/fresh post op)

HHD placement: Just proximal to ankle

Force direction (of tester): Anterior

Norms:

Newtons	Kg	Lb
156.0	15.9	35.1

36.0% of bodyweight

Clinical applications: Hamstring strain/tear/avulsion, PFPS, ACLR, TKA, any knee pathology

Citations:

Thorborg, Kristian, Bandholm, T., & Hölmich, P. (2013). Hip- and knee-strength assessments using a hand-held dynamometer with external belt-fixation are inter-tester reliable. Knee Surgery, Sports Traumatology, Arthroscopy, 21(3), 550–555. https://doi.org/10.1007/s00167-012-2115-2

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Florencio, L. L., Martins, J., da Silva, M. R. B., da Silva, J. R., Bellizzi, G. L., & Bevilaqua-Grossi, D. (2019). Knee and hip strength measurements obtained by a hand-held dynamometer stabilized by a belt and an examiner demonstrate parallel reliability but not agreement. Physical Therapy in Sport, 38, 115–122. https://doi.org/10.1016/j.ptsp.2019.04.011

Peek, K., Gatherer, D., Bennett, K. J. M., Fransen, J., & Watsford, M. (2018). Muscle strength characteristics of the hamstrings and quadriceps in players from a high-level youth football (soccer) Academy. Research in Sports Medicine, 26(3), 276–288. https://doi.org/10.1080/15438627.2018.1447475

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Ankle Plantarflexion

Position: Seated with Calf kit. External fixation is required for plantarflexion strength testing

HHD placement: Metatarsal heads

Force direction (of tester): Superior

Norms:

Newtons	Kg	Lb
1655.1	169.78	371.47

54.1% of bodyweight

Clinical applications: Calf tear/strain, Achilles rupture, lateral ankle sprain, any foot/ankle pathology

Citations:

O'Neill S, Weeks A, Nørgaard JE, Jorgensen MG. Validity and intrarater reliability of a novel device for assessing Plantar flexor strength. Son J, ed. PLoS ONE. 2023;18(3):e0282395. doi:10.1371/journal.pone.0282395

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Ankle Dorsiflexion

Position: Long sitting, ankle in neutral, lower leg stabilized

HHD placement: Metatarsal heads

Force direction (of tester): Inferior

Norms:

Newtons	Kg	Lb
177.5	18.1	39.9

30.9% of bodyweight

Clinical applications: Calf tear/strain, Achilles rupture, lateral ankle sprain, any foot/ankle pathology, drop foot

Citations:

Buckinx, F., Croisier, J. L., Reginster, J. Y., Dardenne, N., Beaudart, C., Slomian, J., Leonard, S., & Bruyère, O. (2017). Reliability of muscle strength measures obtained with a hand-held dynamometer in an elderly population. Clinical Physiology and Functional Imaging, 37(3), 332–340. https://doi.org/10.1111/cpf.12300

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Daloia, L. M. T., Leonardi-Figueiredo, M. M., Martinez, E. Z., & Mattiello-Sverzut, A. C. (2018). Isometric muscle strength in children and adolescents using Handheld dynamometry: reliability and normative data for the Brazilian population. Brazilian Journal of Physical Therapy, 22(6), 474–483. https://doi.org/10.1016/j.bjpt.2018.04.006

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Kim, S.-G., & Lee, Y.-S. (n.d.). *The intra-and inter-rater reliabilities of lower extremity muscle strength assessment of healthy adults using a hand held dynamometer*.
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Earl-Boehm, J. E., Poel, D. N., Zalewski, K., & Ebersole, K. T. (2020). The effects of military style ruck marching on lower extremity loading and muscular, physiological and perceived exertion in ROTC cadets. Ergonomics, 63(5), 629–638. https://doi.org/10.1080/00140139.2020.1745900

Hirunyaphinun, B., Taweetanalarp, S., & Tantisuwat, A. (2019). Relationships between lower extremity strength and the multi-directional reach test in children aged 7 to 12 years. Hong Kong Physiotherapy Journal, 39(2), 143–150. https://doi.org/10.1142/S1013702519500136

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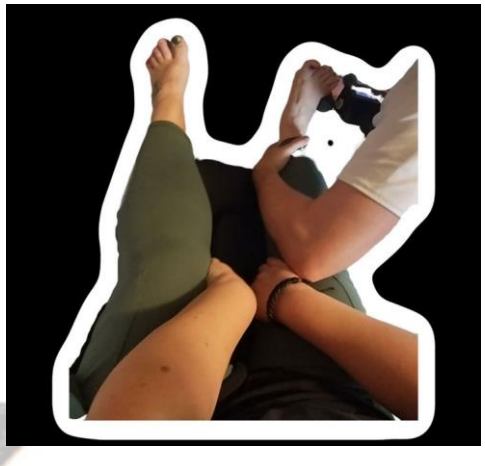
Andrews, A., Thomas, M., & Bohannon, R. (1996). Normative Values for Isometric Muscle Force Measurements Obtained With Hand-held Dynamometers.

Błazkiewicz, M., Sundar, L., Healy, A., Ramachandran, A., Chockalingam, N., & Naemi, R. (2015). Assessment of lower leg muscle force distribution during isometric ankle dorsi and plantar flexion in patients with diabetes: A preliminary study. Journal of Diabetes and Its Complications, 29(2), 282–287. https://doi.org/10.1016/j.jdiacomp.2014.10.007

Ankle Eversion



Position: Long sitting, ankle in neutral, lower leg stabilized

HHD placement: 5th Metatarsal head

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
110.5	11.3	24.8

16.7% of bodyweight

Clinical applications: Calf tear/strain, Achilles rupture, lateral ankle sprain, any foot/ankle pathology

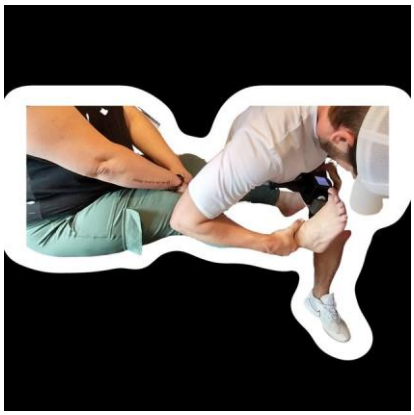
Citations:

Kelln, B. M., Mckeon, P. O., Gontkof, L. M., & Hertel, J. (2008). Hand-Held Dynamometry: Reliability of Lower Extremity Muscle Testing in Healthy, Physically Active, Young Adults. In *Journal of Sport Rehabilitation* (Vol. 17).

Earl-Boehm, J. E., Poel, D. N., Zalewski, K., & Ebersole, K. T. (2020). The effects of military style ruck marching on lower extremity loading and muscular, physiological and perceived exertion in ROTC cadets. Ergonomics, 63(5), 629–638. https://doi.org/10.1080/00140139.2020.1745900

Błazkiewicz, M., Sundar, L., Healy, A., Ramachandran, A., Chockalingam, N., & Naemi, R. (2015). Assessment of lower leg muscle force distribution during isometric ankle dorsi and plantar flexion in patients with diabetes: A preliminary study. Journal of Diabetes and Its Complications, 29(2), 282–287. https://doi.org/10.1016/j.jdiacomp.2014.10.007

Ankle Inversion



Position: Long sitting, ankle in neutral, lower leg stabilized

HHD placement: 1st Metatarsal head

Force direction (of tester): Lateral

Norms:

Newtons	Kg	Lb
139.2	14.2	31.3

22.4% of bodyweight

Clinical applications: Calf tear/strain, Achilles rupture, lateral ankle sprain, any foot/ankle pathology

Citations:

Kelln, B. M., Mckeon, P. O., Gontkof, L. M., & Hertel, J. (2008). Hand-Held Dynamometry: Reliability of Lower Extremity Muscle Testing in Healthy, Physically Active, Young Adults. In *Journal of Sport Rehabilitation* (Vol. 17).

de Moura Campos Carvalho e Silva, A. P., Magalhaes, E., Fernandes, F., & Fukuda, T. Y. (2014). Comparison of Isometric Ankle Strength Between Females with and without Patellofemoral Pain Syndrome. *IJSPT*, *9*(3), 628–634.

Earl-Boehm, J. E., Poel, D. N., Zalewski, K., & Ebersole, K. T. (2020). The effects of military style ruck marching on lower extremity loading and muscular, physiological and perceived exertion in ROTC cadets. Ergonomics, 63(5), 629–638. https://doi.org/10.1080/00140139.2020.1745900

Błazkiewicz, M., Sundar, L., Healy, A., Ramachandran, A., Chockalingam, N., & Naemi, R. (2015). Assessment of lower leg muscle force distribution during isometric ankle dorsi and plantar flexion in patients with diabetes: A preliminary study. Journal of Diabetes and Its Complications, 29(2), 282–287. https://doi.org/10.1016/j.jdiacomp.2014.10.007

Cervical Flexion

Position: Seated, feet flat on the ground, neck in neutral

HHD placement: Forehead

Force direction (of tester): Posterior

Norms:

Newtons	Kg	Lb
49.9	5.1	11.2

17.0% of bodyweight

Clinical applications: Neck pain, radiculopathy, concussion, WAD

Citations:

Krause, D. A., Hansen, K. A., Hastreiter, M. J., Kuhn, T. N., Peichel, M. L., & Hollman, J. H. (2019). A Comparison of Various Cervical Muscle Strength Testing Methods Using a Handheld Dynamometer. Sports Health, 11(1), 59–63. https://doi.org/10.1177/1941738118812767

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Vannebo, K. T., Iversen, V. M., Fimland, M. S., & Mork, P. J. (2018). Test-retest reliability of a handheld dynamometer for measurement of isometric cervical muscle strength. Journal of Back and Musculoskeletal Rehabilitation, 31(3), 557–565. https://doi.org/10.3233/BMR-170829

Collins, C. L., Fletcher, E. N., Fields, S. K., Kluchurosky, L., Rohrkemper, M. K., Comstock, R. D., & Cantu, R. C. (2014). Neck Strength: A Protective Factor Reducing Risk for Concussion in High School Sports. Journal of Primary Prevention, 35(5), 309–319. https://doi.org/10.1007/s10935-014-0355-2

Geary, K., Green, B. S., & Delahunt, E. (2013). Intrarater reliability of neck strength measurement of rugby union players using a handheld dynamometer. Journal of Manipulative and Physiological Therapeutics, 36(7), 444–449. https://doi.org/10.1016/j.jmpt.2013.05.026

Krause, D. A., Hansen, K. A., Hastreiter, M. J., Kuhn, T. N., Peichel, M. L., & Hollman, J. H. (2019). A Comparison of Various Cervical Muscle Strength Testing Methods Using a Handheld Dynamometer. Sports Health, 11(1), 59–63. https://doi.org/10.1177/1941738118812767

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Carnevalli, A. P. de O., Bevilaqua-Grossi, D., Oliveira, A. I. S., Carvalho, G. F., Fernández-De-Las-Peñas, C., & Florencio, L. L. (2018). Intrarater and Inter-rater Reliability of Maximal Voluntary Neck Muscle Strength Assessment Using a Handheld Dynamometer in Women With Headache and Healthy Women. Journal of Manipulative and Physiological Therapeutics, 41(7), 621–627. https://doi.org/10.1016/j.jmpt.2018.01.006

Cervical Extension

Position: Seated, feet flat on the ground, neck in neutral

HHD placement: Occiput

Force direction (of tester): Anterior

Norms:

Newtons	Kg	Lb
51.8	5.3	11.6

30.2% of bodyweight

Clinical applications: Neck pain, radiculopathy, concussion, WAD

Citations:

Krause, D. A., Hansen, K. A., Hastreiter, M. J., Kuhn, T. N., Peichel, M. L., & Hollman, J. H. (2019). A Comparison of Various Cervical Muscle Strength Testing Methods Using a Handheld Dynamometer. Sports Health, 11(1), 59–63. https://doi.org/10.1177/1941738118812767

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Cervical Side Bending

Position: Seated, feet flat on the ground, neck in neutral

HHD placement: Above ear

Force direction (of tester): Medial

Norms:

Newtons	Kg	Lb
45.9	4.7	10.3

23.9% of bodyweight

Clinical applications: Neck pain, radiculopathy, concussion, WAD

Citations:

Kubas, C., Chen, Y.-W., Echeverri, S., Mccann, S. L., Denhoed, M. J., Walker, C. J., Kennedy, C. N., & Reid, A. W. D. (n.d.). *RELIABILITY AND VALIDITY OF CERVICAL RANGE OF MOTION AND MUSCLE STRENGTH TESTING*. www.nsca.com

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