

# Outcomes in Orthopaedic Physical Therapy Practice

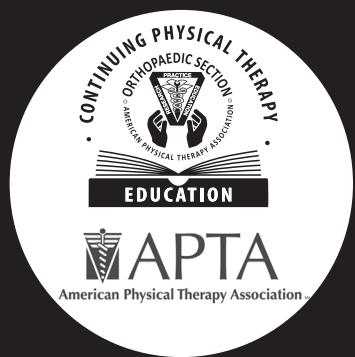
Independent Study Course 26.1.4

## Upper Extremity Outcome Measures



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## REFERENCES

1. Jette DU, Halbert J, Iverson C, Miceli E, Shah P. Use of standardized outcome measures in physical therapist practice: Perceptions and applications. *Phys Ther.* 2009;89(2):125-135. doi: 10.2522/ptj.20080234. Epub 2008 Dec 12.
2. Russek L, Wooden M, Ekedahl S, Bush A. Attitudes toward standardized data collection. *Phys Ther.* 1997;77(7):714-729.
3. Michener LA, Leggin BG. A review of self-reported scales for the assessment of functional limitation and disability of the shoulder. *J Hand Ther.* 2001;14(2):68-76.
4. Michener LA. Patient- and clinician-rated outcome measures in clinical decision making in rehabilitation. *J Sport Rehabil.* 2011;20(1):37-45.
5. Horn KK, Jennings S, Richardson G, Vliet DV, Hefford C, Abbott JH. The patient-specific functional scale: psychometrics, clinimetrics, and application as a clinical outcome measure. *J Orthop Sports Phys Ther.* 2012;42(1):30-42. doi: 10.2519/jospt.2012.3727. Epub 2011 Oct 25.
6. Roy JS, MacDermid JC, Woodhouse LJ. Measuring shoulder function: a systematic review of four questionnaires. *Arthritis Rheum.* 2009;61(5):623-632. doi: 10.1002/art.24396.
7. Gabel CP, Michener LA, Burkett B, Neller A. The Upper Limb Functional Index: Development and determination of reliability, validity, and responsiveness. *J. Hand Ther.* 2006;19(3):328-348; quiz 349.
8. Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder, and Hand outcome measure in different regions of the upper extremity. *J Hand Ther.* 2001;14(2):128-142.
9. Schmitt JS, Di Fabio RP. Reliable change and minimum important difference (MID) proportions facilitated group responsiveness comparisons using individual threshold criteria *J Clin Epidemiol.* 2004;57(10):1008-1018.
10. Lehman LA, Sindhu BS, Shechtman O, Romero S, Velozo CA. A comparison of the ability of two upper extremity assessments to measure change in function. *J Hand Ther.* 2010;23(1):31-39; quiz 40. doi: 10.1016/j.jht.2009.09.006. Epub 2009 Nov 26.
11. Gabel CP, Michener LA, Melloh M, Burkett B. Modification of the Upper Limb Functional Index to a three-point response improves clinimetric properties. *J. Hand Ther.* 2010;23(1):41-51; quiz 52. doi: 10.1016/j.jht.2009.09.007. Epub 2009 Dec 5.
12. Stratford PW, Binkley JM, Stratford D. Development and initial validation of the upper extremity functional index. *Physiother Can.* 2001;53:259-267.
13. Chesworth BM, Hamilton CB, Walton DM, et al. Reliability and validity of two versions of the upper extremity functional index. *Physiother Can.* 2014;66(3):243-253. doi: 10.3138/ptc.2013-45.
14. Hefford C, Abbott JH, Arnold R, Baxter GD. The patient-specific functional scale: validity, reliability, and responsiveness in patients with upper extremity musculoskeletal problems. *J Orthop Sports Phys Ther.* 2012;42(2):56-65. doi: 10.2519/jospt.2012.3953. Epub 2012 Feb 1.
15. St-Pierre C, Desmeules F, Dionne CE, Fremont P, MacDermid JC, Roy JS. Psychometric properties of self-reported questionnaires for the evaluation of symptoms and functional limitations in individuals with rotator cuff disorders: A systematic review. *Disabil Rehabil.* 2016;38(2):103-22. doi: 10.3109/09638288.2015.1027004. Epub 2015 Mar 24.
16. Dale LM, Strain-Riggs SR. Comparing responsiveness of the Quick Disabilities of the Arm, Shoulder, and Hand and the Upper Limb Functional Index. *Work.* 2013;46(3):243-250. doi: 10.3233/WOR-2012-1467.
17. de Witte PB, Henseler JF, Nagels J, Vliet Vlieland TP, Nelissen RG. The Western Ontario rotator cuff index in rotator cuff disease patients: a comprehensive reliability and responsiveness validation study. *Am J Sports Med.* 2012;40(7):1611-1619. doi: 10.1177/0363546512446591. Epub 2012 May 10.
18. Pransky G, Feuerstein M, Himmelstein J, Katz JN, Vickers-Lahti M. Measuring functional outcomes in work-related upper extremity disorders: Development and validation of Upper Extremity Function Scale. *J Occup Environ Med.* 1997;39(12):1195-1202.
19. Resnik L, Borgia M. Reliability, validity, and responsiveness of the QuickDASH in patients with upper limb amputation. *Arch Phys Med Rehabil.* 2015;96(9):1676-1683. doi: 10.1016/j.apmr.2015.03.023. Epub 2015 Apr 23.
20. McClure P, Michener L. Measures of adult shoulder function: The American Shoulder and Elbow Surgeons Standardized Shoulder Form Patient Self-Report Section (ASES), Disabilities of the Arm, Shoulder, and Hand (DASH), Shoulder Disability Questionnaire, Shoulder Pain and Disability Index (SPADI), and Simple Shoulder Test. *Arthritis Rheum.* 2003;49(S5):S50-S58.

21. Leggin BG, Michener LA, Shaffer MA, Brenneman SK, Iannotti JP, Williams Jr. GR. The Penn Shoulder Score: Reliability and validity. *J Orthop Sports Phys Ther.* 2006;36(3):138-151.
22. Alberta FG, ElAttrache NS, Bissell S, et al. The development and validation of a functional assessment tool for the upper extremity in the overhead athlete. *Am J Sports Med.* 2010;38(5):903-911. doi: 10.1177/0363546509355642. Epub 2010 Mar 24.
23. Slobogean GP, Noonan VK, O'Brien PJ. The reliability and validity of the Disabilities of Arm, Shoulder, and Hand, EuroQol-5D, Health Utilities Index, and Short Form-6D outcome instruments in patients with proximal humeral fractures. *J Shoulder Elbow Surg.* 2010;19(3):342-348. doi: 10.1016/j.jse.2009.10.021. Epub 2010 Mar 1.
24. Hunsaker FG, Cioffi DA, Amadio PC, Wright JG, Caughlin B. The American Academy of Orthopedic Surgeons outcomes instruments normative values from the general population. *J Bone Joint Surg.* 2002;84-A(2):208-215.
25. Hudak P, Amadio PC, Bombardier C, Group UEC. Development of an upper extremity outcome measure: The DASH (Disabilities of the Arm, Shoulder, and Hand) [corrected]. The Upper Extremity Collaborative Group (UECG). *Am J Ind Med.* 1996;29(6):602-608.
26. Hsu JE, Nacke E, Park MJ, Sennett BJ, Huffman GR. The Disabilities of the Arm, Shoulder, and Hand questionnaire in intercollegiate athletes: validity limited by ceiling effect. *J Shoulder Elbow Surg.* 2010;19(3):349-354. doi: 10.1016/j.jse.2009.11.006.
27. Franchignoni F, Vercelli S, Giordano A, Sartorio F, Bravini E, Ferriero G. Minimal clinically important difference of the Disabilities of the Arm, Shoulder and Hand outcome measure (DASH) and its shortened version (QuickDASH). *J. Orthop. Sports Phys. Ther.* 2014;44(1):30-39. doi: 10.2519/jospt.2014.4893. Epub 2013 Oct 30.
28. Sorensen AA, Howard D, Tan WH, Ketchersid J, Calfee RP. Minimal clinically important differences of 3 patient-rated outcomes instruments. *J Hand Surg Am.* 2013;38(4):641-649. doi: 10.1016/j.jhsa.2012.12.032. Epub 2013 Mar 6.
29. Angst F, Schwyzer HK, Aeschlimann A, Simmen BR, Goldhahn J. Measures of adult shoulder function: Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) and its short version (QuickDASH), Shoulder Pain and Disability Index (SPADI), American Shoulder and Elbow Surgeons (ASES) Society standardized shoulder assessment form, Constant (Murley) Score (CS), Simple Shoulder Test (SST), Oxford Shoulder Score (OSS), Shoulder Disability Questionnaire (SDQ), and Western Ontario Shoulder Instability Index (WOSI). *Arthritis Care Res.* 2011;63 Suppl 11:S174-188. doi: 10.1002/acr.20630.
30. Lopes AD, Vilar e Furtado Rd, Silva CA, Yi LC, Malfatti CA, Araújo SAd. Comparison of self-report and interview administration methods based on the Brazilian versions of the Western Ontario Rotator Cuff Index and Disabilities of the Arm, Shoulder and Hand Questionnaire in patients with rotator cuff disorders. *Clinics (Sao Paulo).* 2009;64(2):121-125.
31. Angst F, Goldhahn J, Drerup S, Aeschlimann A, Schwyzer HK, Simmen BR. Responsiveness of six outcome assessment instruments in shoulder arthroplasty. *Arthritis Rheum.* 2008;59(3):391-398. doi: 10.1002/art.23318.
32. MacDermid JC, Drosdowech D, Faber K. Responsiveness of self-report scales in patients recovering from rotator cuff surgery. *J Shoulder Elbow Surg.* 2006;15(4):407-414.
33. Kirkley A, Griffin S, McLintock H, Ng L. The development and evaluation of a disease-specific quality of life measurement tool for shoulder instability. The Western Ontario Shoulder Instability Index (WOSI). *Am J Sports Med.* 1998;26(6):764-772.
34. Kotsis SV, Chung KC. Responsiveness of the Michigan Hand Outcomes Questionnaire and the Disabilities of the Arm, Shoulder and Hand questionnaire in carpal tunnel surgery. *J Hand Surg Am.* 2005;30(1):81-86.
35. Atroshi I, Gummesson C, Andersson B, Dahlgren E, Johansson A. The Disabilities of the Arm, Shoulder, and Hand (DASH) outcome questionnaire. Reliability and validity of the Swedish version evaluated in 176 patients. *Acta Orthop Scand.* 2000;71(6):613-618.
36. Beaton DE, Wright JG, Katz JN; Upper Extremity Collaborative Group. Development of the QuickDASH: Comparison of three item-reduction approaches. *J Bone Joint Surg.* 2005;87(5):1038-1046.
37. Mintken PE, Glynn P, Cleland JA. Psychometric properties of the shortened disabilities of the Arm, Shoulder, and Hand Questionnaire (QuickDASH) and Numeric Pain Rating Scale in patients with shoulder pain. *J Shoulder Elbow Surg.* 2009;18(6):920-926. doi: 10.1016/j.jse.2008.12.015. Epub 2009 Mar 17.
38. Polson K, Reid D, McNair PJ, Larmer P. Responsiveness, minimal importance difference and minimal detectable change scores of the shortened Disability Arm Shoulder Hand (QuickDASH) questionnaire. *Man Ther.* 2010;15(4):404-407. doi: 10.1016/j.math.2010.03.008.
39. Kennedy CA, Beaton DE, Smith P, et al. Measurement properties of the QuickDASH

- (disabilities of the arm, shoulder and hand) outcome measure and cross-cultural adaptations of the QuickDASH: A systematic review. *Qual Life Res.* 2013;22(9):2509-2547. doi: 10.1007/s11136-013-0362-4. Epub 2013 Mar 12.
40. van Kampen DA, Willems WJ, van Beers LWAH, Castelein RM, Scholtes VA, Terwee CB. Determination and comparison of the smallest detectable change (SDC) and the minimal important change (MIC) of four-shoulder patient-reported outcome measures (PROMs). *J Orthop Surg Res.* 2013;8:40. doi: 10.1186/1749-799X-8-40.
41. Reza Nourbakhsh M, Fearon FJ. An alternative approach to treating lateral epicondylitis. A randomized, placebo-controlled, double-blinded study. *Clin Rehabil.* 2008;22(7):601-609. doi: 10.1177/0269215507088447.
42. Nourbakhsh MR, Fearon FJ. The effect of oscillating-energy manual therapy on lateral epicondylitis: a randomized, placebo-control, double-blinded study. *J Hand Ther.* 2008;21(1):4-13; quiz 14. doi: 10.1197/j.jht.2007.09.005.
43. Koehorst ML, van Trijffel E, Lindeboom R. Evaluative measurement properties of the Patient-Specific Functional Scale for primary shoulder complaints in physical therapy practice. *J Orthop Sports Phys Ther.* 2014;44(8):595-603. doi: 10.2519/jospt.2014.5133. Epub 2014 Jul 16.
44. McMillan CR, Binhammer PA. Which outcome measure is the best? Evaluating responsiveness of the Disabilities of the Arm, Shoulder, and Hand Questionnaire, the Michigan Hand Questionnaire and the Patient-Specific Functional Scale following hand and wrist surgery. *Hand (N Y).* 2009;4(3):311-318. doi: 10.1007/s11552-009-9167-x. Epub 2009 Mar 4.
45. Gross DP, Battie MC, Asante AK. The Patient-Specific Functional Scale: validity in workers' compensation claimants. *Arch Phys Med Rehabil.* 2008;89(7):1294-1299. doi: 10.1016/j.apmr.2007.11.040. Epub 2008 Jun 13.
46. Wylie JD, Beckmann JT, Granger E, Tashjian RZ. Functional outcomes assessment in shoulder surgery. *World J Orthop.* 2014;5(5):623-633. doi: 10.5312/wjo.v5.i5.623. eCollection 2014.
47. Menon J, Cappelleri J, Mardekian J, Vendetti N, Mychaskiw M, Ili J. Psychometric properties of the SF-12, Penn Shoulder Score, and Visual Analogue Scale-Pain for rotator cuff retears. *Appl Med Res.* 2015;1(3):109-117.
48. Richards RR, An K-N, Bigliani LU, et al. A standardized method for assessment of shoulder function. *J Shoulder Elbow Surg.* 1994;3(6):347-352.
49. Michener LA, McClure PW, Sennett BJ. American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form, patient self-report section: reliability, validity, and responsiveness. *J Shoulder Elbow Surg.* 2002;11(6):587-594.
50. Kocher MS, Horan MP, Briggs KK, Richardson TR, O'Holleran J, Hawkins RJ. Reliability, validity, and responsiveness of the American Shoulder and Elbow Surgeons Subjective Shoulder Scale in patients with shoulder instability, rotator cuff disease, and glenohumeral arthritis. *J Bone Joint Surg.* 2005;87(9):2006-2011.
51. Beaton D, Richards RR. Assessing the reliability and responsiveness of 5 shoulder questionnaires. *J Shoulder Elbow Surg.* 1998;7(6):565-572.
52. Cook KF, Roddey TS, Olson SL, Gartsman GM, Valenzuela FFT, Hanten WP. Reliability by surgical status of self-reported outcomes in patients who have shoulder pathologies. *J Orthop Sports Phys Ther.* 2002;32(7):336-346.
53. Goldhahn J, Angst F, Drerup S, Pap G, Simmen BR, Mannion AF. Lessons learned during the cross-cultural adaptation of the American Shoulder and Elbow Surgeons shoulder form into German. *J Shoulder Elbow Surg.* 2008;17(2):248-254. doi: 10.1016/j.jse.2007.06.027. Epub 2008 Jan 22.
54. Tashjian RZ, Deloach J, Green A, Porucznik CA, Powell AP. Minimal clinically important differences in ASES and Simple Shoulder Test scores after nonoperative treatment of rotator cuff disease. *J Bone Joint Surg.* 2010;92(2):296-303. doi: 10.2106/JBJS.H.01296.
55. Oh JH, Jo KH, Kim WS, Gong HS, Han SG, Kim YH. Comparative evaluation of the measurement properties of various shoulder outcome instruments. *Am J Sports Med.* 2009;37(6):1161-1168.
56. Razmjou H, Bean A, van Osnabrugge V, MacDermid JC, Holtby R. Cross-sectional and longitudinal construct validity of two rotator cuff disease-specific outcome measures. *BMC Musculoskelet Disord.* 2006;7:26.
57. Rouleau DM, Faber K, MacDermid JC. Systematic review of patient-administered shoulder functional scores on instability. *J Shoulder Elbow Surg.* 2010;19(8):1121-1128. doi: 10.1016/j.jse.2010.07.003.
58. Holtby R, Razmjou H. Measurement properties of the Western Ontario Rotator Cuff outcome measure: A preliminary report. *J Shoulder Elbow Surg.* 2005;14(5):506-510.
59. Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a Shoulder Pain and Disability Index. *Arthritis Care Res.* 1991;4(4):143-149.
60. Ekeberg OM, Bautz-Holter E, Tveita EK, Keller A, Juel NG, Brox JI. Agreement, reliability and validity in 3 shoulder questionnaires in patients with rotator cuff disease. *BMC Musculoskeletal*

- Disorders* 2008;9:68. doi: 10.1186/1471-2474-9-68.
61. Roach KE, Budiman-Mak E, Sangsiridej N, Lertrantanakul Y. Development of a shoulder pain disability index. *Arthritis Care Res.* 1991;4(4):143-149.
62. Ekeberg OM, Bautz-Holter E, Keller A, Tveita EK, Juel NG, Brox JI. A questionnaire found disease-specific WORC index is not more responsive than SPADI and OSS in rotator cuff disease. *J Clin Epidemiol.* 2010;63(5):575-584. doi: 10.1016/j.jclinepi.2009.07.012.
63. Staples MP, Forbes A, Green S, Buchbinder R. Shoulder-specific disability measures showed acceptable construct validity and responsiveness. *J Clin Epidemiol.* 2010;63(2):163-170. doi: 10.1016/j.jclinepi.2009.03.023. Epub 2009 Aug 14.
64. Williams JW Jr, Holleman DR Jr, Simel DL. Measuring shoulder function with the Shoulder Pain and Disability Index. *J Rheumatol.* 1995;22(4):727-732.
65. Dupeyron A, Gelis A, Sablayrolles P, et al. Heterogeneous assessment of shoulder disorders: validation of the Standardized Index of Shoulder Function. *J Rehabil Med.* 2010;42(10):967-972. doi: 10.2340/16501977-0627.
66. Huang H, Grant JA, Miller BS, Mirza FM, Gagnier JJ. A systematic review of the psychometric properties of patient-reported outcome instruments for use in patients with rotator cuff disease. *Am. J. Sports Med.* 2015;43(10):2572-2582. doi: 10.1177/0363546514565096. Epub 2015 Jan 26.
67. Roddey TS, Olson SL, Cook KF, Gartsman GM, Hanten W. Comparison of the University of California-Los Angeles Shoulder Scale and the Simple Shoulder Test with the Shoulder pain and Disability Index: Single-administration reliability and validity. *Phys Ther.* 2000;80(8):759-768.
68. Godfrey J, Hamman R, Lowenstein S, Briggs K, Kocher M. Reliability, validity, and responsiveness of the simple shoulder test: psychometric properties by age and injury type. *J Shoulder Elbow Surg.* 2007;16(3):260-267. Epub 2006 Dec 22.
69. van de Water AT, Shields N, Davidson M, Evans M, Taylor NF. Reliability and validity of shoulder function outcome measures in people with a proximal humeral fracture. *Disabil Rehabil.* 2014;36(13):1072-1079. doi: 10.3109/09638288.2013.829529. Epub 2013 Sep 3.
70. Henseler JF, Kolk A, van der Zwaal P, Nagels J, Vliet Vlieland TP, Nelissen RG. The minimal detectable change of the Constant score in impingement, full-thickness tears, and massive rotator cuff tears. *J Shoulder Elbow Surg.* 2015;24(3):376-381. doi: 10.1016/j.jse.2014.07.003. Epub 2014 Sep 17.
71. van Den Ende CH, Rozing PM, Dijkmans BA, Verhoef JA. Assessment of shoulder function in rheumatoid arthritis. *J Rheumatol.* 1996;23(12):2043-2048.
72. Kukkonen J, Kauko T, Vahlberg T, Joukinen A, Aarimaa V. Investigating minimal clinically important difference for Constant score in patients undergoing rotator cuff surgery. *J Shoulder Elbow Surg.* 2013;22(12):1650-1655. doi: 10.1016/j.jse.2013.05.002. Epub 2013 Jul 12.
73. Holmgren T, Oberg B, Adolfsson L, Bjornsson Hallgren H, Johansson K. Minimal important changes in the Constant-Murley score in patients with subacromial pain. *J. Shoulder Elbow Surg.* 2014;23(8):1083-1090. doi: 10.1016/j.jse.2014.01.014. Epub 2014 Apr 13.
74. Christiansen DH, Frost P, Falla D, Haahr JP, Frich LH, Svendsen SW. Responsiveness and minimal clinically important change: A comparison between 2 shoulder outcome measures. *J Orthop Sports Phys Ther.* 2015;45(8):620-625. doi: 10.2519/jospt.2015.5760. Epub 2015 Jun 25.
75. Lo IK, Litchfield RB, Griffin S, Faber K, Patterson SD, Kirkley A. Quality-of-life outcome following hemiarthroplasty or total shoulder arthroplasty in patients with osteoarthritis: A prospective, randomized trial. *J Bone Joint Surg.* 2005;87(10):2178-2185.
76. O'Connor DA, Chipchase LS, Tomlinson J, Krishnan J. Arthroscopic subacromial decompression: Responsiveness of disease-specific and health-related quality of life outcome measures. *Arthroscopy.* 1999;15(8):836-840.
77. Roy JS, MacDermid JC, Woodhouse LJ. A systematic review of the psychometric properties of the Constant-Murley score. *J Shoulder Elbow Surg.* 2010;19(1):157-164.
78. Dawson J, Fitzpatrick R, Carr A. The assessment of shoulder instability. *J Bone Joint Surg.* 1999;81-B:420-426.
79. Gilbart MK, Gerber C. Comparison of the subjective shoulder value and the Constant score. *J Shoulder Elbow Surg.* 2007;16(6):717-721.
80. Dawson J, Fitzpatrick R, Carr A. Questionnaire on the perceptions of patients about shoulder surgery. *J Bone Joint Surg Br.* 1996;78(4):593-600.
81. Dawson J, Rogers K, Fitzpatrick R, Carr A. The Oxford Shoulder Score revisited. *Arch Orthop Trauma Surg.* 2009;129(1):119-123.
82. Smith MV, Calfee RP, Baumgarten KM, Brophy RH, Wright RW. Upper extremity-specific measures of disability and outcomes in orthopaedic surgery. *J. Bone Joint Surg.* 2012;94(3):277-285. doi: 10.2106/JBJS.J.01744.

83. Placzek JD, Lukens SC, Badalamente S, et al. Shoulder outcome measures: A comparison of 6 functional tests. *Am J Sports Med*. 2004;32(5):1270-1277.
84. Coghlan JA, Bell SN, Forbes A, Buchbinder R. Comparison of self-administered University of California, Los Angeles, shoulder score with traditional University of California, Los Angeles, shoulder score completed by clinicians in assessing the outcome of rotator cuff surgery. *J Shoulder Elbow Surg*. 2008;17(4):564-569.
85. Domb BG, Davis JT, Alberta FG, et al. Clinical follow-up of professional baseball players undergoing ulnar collateral ligament reconstruction using the new Kerlan-Jobe Orthopaedic Clinic overhead athlete shoulder and elbow score (KJOC Score). *Am J Sports Med*. 2010;38(8):1558-1563.
86. Changulani M, Okonkwo U, Keswani T, Kalairajah Y. Outcome evaluation measures for wrist and hand: which one to choose? *Int Orthop*. 2008;32(1):1-6.
87. Hoang-Kim A, Pegreffi F, Moroni A, Ladd A. Measuring wrist and hand function: common scales and checklists. *Injury*. 2011;42(3):253-258.
88. MacDermid JC. The Patient-Rated Wrist/Hand Evaluation. In: School of Rehabilitation Science MU, ed 2009.
89. MacDermid J. The Patient-Rated Wrist Evaluation (PRWE) User Manual. 2011:1-37.
90. Badalamente M, Coffelt L, Elfar J, et al. Measurement scales in clinical research of the upper extremity, part 1: general principles, measures of general health, pain, and patient satisfaction. *J Hand Surg Am*. 2013;38(2):401-406; quiz 406. doi: 10.1016/j.jhsa.2012.11.028.
91. MacDermid JC, Turgeon T, Richards RS, Donner A, Bellamy N, Roth JH. Responsiveness of SF-36, DASH, and PRWE and physical impairments in evaluating recovery after distal radius fractures *J Hand Surg Am*. 2000;12:77-86.
92. MacDermid JC, Tottenham V. Responsiveness of the disability of the arm, shoulder, and hand (DASH) and patient-rated wrist/hand evaluation (PRWHE) in evaluating change after hand therapy. *J Hand Ther*. 2004;17(1):18-23.
93. MacDermid JC. Outcome evaluation in patients with elbow pathology: Issues in instrument development and evaluation. *J Hand Ther*. 2001;14(2):105-114.
94. Angst F, Goldhahn J, Drerup S, et al. Responsiveness of five outcome measurement instruments in total elbow arthroplasty. *Arthritis Care Res*. 2012;64(11):1749-1755.
95. Kirkley A, Alvarez C, Griffin S. The development and evaluation of disease-specific quality-of-life questionnaire for disorders of the rotator cuff: The Western Ontario Rotator Cuff Index. *Clin J Sports Med*. 2003;13(2):84-92.
96. Kirkley A, Griffin S, Dainty K. Scoring systems for functional assessment of the shoulder. *Arthroscopy*. 2003;19(10):1109-1120.
97. Hollinshead RM, Mohtadi NG, Vande Guchte RA, Wadey VM. Two 6-year follow-up studies of large and massive rotator cuff tears: Comparison of outcome measures. *J Shoulder Elbow Surg*. 2000;9(5):373-381.
98. Skare O, Liavaag S, Reikeras O, Mowinckel P, Brox JJ. Evaluation of Oxford Instability Shoulder Score, Western Ontario Shoulder Instability Index and Euroqol in patients with SLAP (superior labral anterior posterior) lesions or recurrent anterior dislocations of the shoulder. *BMC Res Notes*. 2013;6(273):1-10.
99. van der Linde JA, Willems WJ, van Kampen DA, van Beers LW, van Deurzen DF, Terwee CB. Measurement properties of the Western Ontario Shoulder Instability index in Dutch patients with shoulder instability. *BMC Musculoskelet Disord*. 2014;15:211. doi: 10.1186/1471-2474-15-211.
100. Skare O, Mowinckel P, Schroder CP, Liavaag S, Reikeras O, Brox JJ. Responsiveness of outcome measures in patients with superior labral anterior and posterior lesions. *Shoulder Elbow*. 2014;6(4):262-272.
101. Levine DW, Simmons BP, Koris MJ, et al. A self-administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg*. 1993;75(11):1585-1592.
102. Sambandam SN, Priyanka P, Gul A, Ilango B. Critical analysis of outcome measures used in the assessment of carpal tunnel syndrome. *Int Orthop*. 2008;32(4):497-504.
103. Levine DW, Simmons PB, Koris MJ, et al. A self administered questionnaire for the assessment of severity of symptoms and functional status in carpal tunnel syndrome. *J Bone Joint Surg*. 1993;75:1585-1592.
104. de Carvalho Leite JC, Jerosch-Herold C, Song F. A systematic review of the psychometric properties of the Boston Carpal Tunnel Questionnaire. *BMC Musculoskelet Disord*. 2006;7(78):1-9.
105. Kim JK, Jeon SH. Minimal clinically important differences in the Carpal Tunnel Questionnaire after carpal tunnel release. *J Hand Surg Eur Vol*. 2013;38(1):75-79. doi: 10.1177/1753193412442137. Epub 2012 Mar 28.
106. Katz JN, Gelberman RH, Wright EA, Lew RA, Liang MH. Responsiveness of self-reported and objective measures of disease severity in carpal tunnel syndrome. *Med Care*. 1994;32:1127-1133.
107. Mondelli M, Ginanneschi F, Rossi S, Reale F, Padua L, Giannini F. Inter-observer reproducibility

- and responsiveness of a clinical severity scale in surgically treated carpal tunnel syndrome. *Acta Neuro Scand.* 2002;106:263-268.
108. Atroshi I, Johnsson R, Sprinchorn A. Self-administered outcome instrument in carpal tunnel syndrome. *Acta Orthop Scand.* 1998;69:82-88.
109. Gay RE, Amadio PC, Johnson JC. Comparative responsiveness of the disabilities of the arm, shoulder, and hand, the carpal tunnel questionnaire, and the SF-36 to clinical change after carpal tunnel release. *J Hand Surg Am.* 2003;28(2):250-254.
110. Chatterjee JS, Price PE. Comparative responsiveness of the Michigan Hand Outcomes Questionnaire and the Carpal Tunnel Questionnaire after carpal tunnel release. *J Hand Surg Am.* 2009;34(2):273-280.
111. Amadio PC, Silverstein MD, Ilstrup DM, Schleck CD, Jensen LM. Outcome assessment for carpal tunnel surgery: The relative responsiveness of generic, arthritis-specific, disease-specific, and physical examination measures. *J Hand Surg Am.* 1996;21A:338-346.
112. Greenslade JR, Mehta RL, Belward P, Warwick D. DASH and Boston Questionnaire assessment of carpal tunnel syndrome outcome: What is the responsiveness of an outcome questionnaire? *J Hand Surg Am.* 2004;29B:159-164.
113. Amirjani N, Ashworth NL, Olson JL, Morhart M, Chan KM. Validity and reliability of the Purdue Pegboard Test in carpal tunnel syndrome. *Muscle Nerve.* 2011;43(2):171-177. doi: 10.1002/mus.21856. Epub 2010 Nov 24.
114. Chung KC, Pillsbury MS, Walters MR, Hayward RA. Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am.* 1998;23:575-587.
115. Massy-Westropp N, Krishnan J, Ahern M. Comparing the AUSCAN Osteoarthritis Hand Index, Michigan Hand Outcomes Questionnaire, and Sequential Occupational Dexterity Assessment for patients with rheumatoid arthritis. *J Rheumatol.* 2004;31:1996-2001.
116. Poole JL, Lucero SL, Mynatt R. Self-reports and performance-based tests of hand function in persons with osteoarthritis. *Phys Occup Ther Geriatr.* 2010;28(3):249-258.
117. Shauver MJ, Chung KC. The Michigan hand outcomes questionnaire after 15 years of field trial. *Plast Reconstr Surg.* 2013;131(5):779e-787e. doi: 10.1097/PRS.0b013e3182865d83.
118. Poole JL, Gonzales I, Tedesco T. Self-reports of hand function in persons with diabetes. *Occup Ther Health Care.* 2010;24(3):239-248. doi: 10.3109/07380571003793957.
119. London DA, Stepan JG, Calfee RP. Determining the Michigan Hand Outcomes Questionnaire minimal clinically important difference by means of three methods. *Plast Reconstr Surg.* 2014;133(3):616-625. doi: 10.1097/PRS.0000000000000034.
120. Chung KC, Hamill JB, Walters MR, Hayward RA. The Michigan Hand Outcomes Questionnaire (MHQ): Assessment of responsiveness to clinical change. *Ann Plast Surg.* 1999;42(6):619-622.
121. Shauver MJ, Chung KC. The minimal clinically important difference of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am.* 2009;34(3):509-514.
122. Sears ED, Chung KC. Validity and responsiveness of the Jebsen-Taylor Hand Function Test. *J Hand Surg Am.* 2010;35(1):30-37.
123. Horng YS, Lin MC, Feng CT, Huang CH, Wu HC, Wang JD. Responsiveness of the Michigan Hand Outcomes Questionnaire and the Disabilities of the Arm, Shoulder, and Hand questionnaire in patients with hand injury. *J Hand Surg Am.* 2010;35(3):430-436.
124. Ozyurekoglu T, McCabe SJ, Goldsmith LJ, Lajoie AS. The minimal clinically important difference of the Carpal Tunnel Syndrome Symptom Severity Scale. *J Hand Surg Am.* 2006;31(5):733-738.
125. Gorman PP, Butler RJ, Plisky PJ, Kiesel KB. Upper Quarter Y Balance Test: reliability and performance comparison between genders in active adults. *J Strength Cond Res.* 2012;26(11):3043-3048.
126. Goldbeck TG, Davies GJ. Test-retest reliability of the closed kinetic chain upper extremity clinical field test. *J Sport Rehabil.* 2000;9:35-45.
127. Westrick RB, Miller JM, Carrow SD, Gerber JP. Exploration of the Y-Balance Test for assessment of upper quarter closed kinetic chain performance. *Int J Sports Phys Ther.* 2012;7(2):139-147.
128. Negrete RJ, Hanney WJ, Kolber MJ, et al. Reliability, minimal detectable change, and normative values for tests of upper extremity function and power. *J Strength Cond Res.* 2010;24(12):3318-3325.
129. Vincent JI, MacDermid JC, Michlovitz SL, et al. The push-off test: development of a simple, reliable test of upper extremity weight-bearing capability. *J Hand Ther.* 2014;27(3):185-190; quiz 191. doi: 10.1016/j.jht.2014.03.002. Epub 2014 Mar 12.
130. MacDermid JC, Ghobrial M, Quirion KB, et al. Validation of a new test that assesses functional performance of the upper extremity and neck (FIT-HaNSA) in patients with shoulder pathology. *BMC Musculoskelet Disord.* 2007;8:42.
131. Kumata P, MacDermid JC, Mehta S, Stratford PW. The Fit-HaNSA demonstrates reliability and convergent validity of functional performance in patients with shoulder disorders. *J Orthop Sports*

- Phys Ther.* 2012;42(5):455-464. doi: 10.2519/jospt.2012.3796. Epub 2012 Jan 25.
132. Mathiowetz V, Volland G, Kashman N, Weber K. Adult norms for the Box-and-Block test for manual dexterity. *Am J Occup Ther.* 1985;39(6):386-391.
  133. Platz T, Pinkowski C, van Wijck F, Kim I-H, di Bella P, Johnson G. Reliability and validity of arm function assessment with standardized guidelines for the Fugl-Meyer Test, Action Research Arm Test and Box and Block Test: A multicentre study. *Clin Rehabil.* 2005;19(4):404-411.
  134. Connell LA, Tyson SF. Clinical reality of measuring upper-limb ability in neurologic conditions: a systematic review. *Arch Phys Med Rehabil.* 2012;93(2):221-228. doi: 10.1016/j.apmr.2011.09.015.
  135. Yancosek KE, Howell D. A narrative review of dexterity assessments. *J Hand Ther.* 2009;22(3):258-269.
  136. Aaron DH, Jansen CW. Development of the Functional Dexterity Test (FDT): Construction, validity, reliability, and normative data. *J Hand Ther.* 2003;16:12-21.
  137. Sartorio F, Bravini E, Vercelli S, et al. The Functional Dexterity Test: test-retest reliability analysis and up-to date reference norms. *J Hand Ther.* 2013;26(1):62-67; quiz 68. doi: 10.1016/j.jht.2012.08.001. Epub 2012 Oct 3.
  138. Ratliff JL. Validity Testing for the Functional Dexterity Test. Houston, TX: Texas Women's University; 1991.
  139. Tiffin J, Asher Ej. The Purdue Pegboard: Norms and studies of reliability and validity. *J Appl Psychol.* 1948;32:234-247.
  140. Gallus J, Mathiowetz V. Test-retest reliability of the Purdue Pegboard for persons with multiple sclerosis. *Am J Occup Ther.* 2003;57:108-111.
  141. Desrosiers RH, Bravo G, Dutil E. The Purdue Pegboard Test: Normative data for people aged 60 and over. *Disabil Rehabil.* 1995;17(5):217-224.
  142. Buddenberg LA, Davis C. Test-retest reliability of the Purdue Pegboard Test. *Am J Occup Ther.* 2000;54(5):555-558.
  143. Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. *Arch Phys Med Rehabil.* 1969;50:311-319.
  144. Hackel ME, Wolfe GA, Bang SM, Canfield JS. Changes in hand function in the aging adult as determined by the Jebsen Test of Hand Function. *Phys Ther.* 1992;72(5):373-377.
  145. Lynch KB, Bridle MJ. Validity of the Jebsen-Taylor Hand Function Test in predicting activities of daily living. *Occup Ther J Res.* 1989;9(5):316-319.