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Research Summary – Manual Muscle Testing (MMT) – Other Physiological Systems

Author Year Country Research Design Setting	Demographics and Injury Characteristics of Sample	Validity	Reliability	Responsiveness Interpretability
Bye et al. 2021 Study to determine the inter-rater reliability of the 13-point manual muscle test (MMT) in two upper limb muscle groups of people with tetraplegia Three SCI units	N = 60 48M, 12F Median (IQR) age 55 (35 to 69) years Neurological level: C1-C4 (n = 32), C5-C8 (n = 28) AIS classification: A (n = 17), B (n = 14), C (n = 13), and D (n = 16) Median (IQR) time since injury 4 (1.5 to 24) months Strength of the elbow flexors and/or wrist extensors was measured by two physiotherapists on the same day.		The weighted kappa coefficients (95% confidence interval) reflecting the agreement of the two assessors for the wrist extensors and elbow flexors were 0.96 (0.93 to 0.99) and 0.94 (0.89 to 0.99), respectively.	
Burns et al. 2011 Cross-sectional validation of WISCI II	Patients who are able to ambulate >= 10m N=76, 79% male Mean age: 43.3±13.8	Spearman correlations btwn Manual Muscle Test (Upper & Lower Extremity) (N=75) and:		

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MMT scale version unknown Regional Spinal Cord Injury Center of the Delaware Valley	Mean post-injury time: 6.32±5.99 years 45% paraplegia, 55% tetraplegia AIS-A/B/C/D: 3%/1%/8%/88%	Self-selected WISCI level: 0.647 (p<0.0001) Self-selected WISCI speed: 0.494 (p<0.0001) Max WISCI level: 0.663 (p<0.0001) Max WISCI speed: 0.539 (p<0.0001) More details of paraplegic/tetraplegic values available in article.		
Rudhe et al. 2009 Cross-sectional analysis. Part of larger international multicenter GRASSP study.	N = 29 with traumatic or ischemic SCI Time since injury = 1-15 months (mean = 4.5 ± 3 months) Age= 19-81 years (mean = 50 ± 18 years) 16 males, 13 females ASIA-A/B/CD: 12/4/13	SCIM III scores correlated well with UEMS, MMT and hand capacity tests total scores (P<0.001): *Room & toilet and indoors/outdoors **Upper limb / hand muscles used for MMT		

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MMT scale version unknown 2 German centers and 1 Swiss center.		Please see Table 1 below. Please see Table 2 below. Estimation of SCIM-III Self care score using MMT: $R^2_{adjusted} = 0.73$		

Table 1

SCIM III	MMT
Feeding	0.75
Bathing upper body	0.77
Bathing lower body	0.76
Dressing upper body	0.76
Dressing lower body	0.70
Grooming	0.89
Self-care Total	0.84
Respiration & Bladder Total	0.68
Mobility Total*	0.71
Total Score	0.78

Table 2

Spearman's correlations between MMT and SCIM-III Self Care items							
MMT Items	Feeding	Bathing Upper Body	Bathing Lower Body	Dressing Upper Body	Dressing Lower Body	Grooming	Self-care Total

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	Shoulder Abduction	0.55	0.61	0.41	0.66	0.34		0.47	0.61
	Elbow Extension	0.62	0.75	0.63	0.66	0.62		0.78	0.70
	Elbow Flexion	0.27	0.40	0.08	0.39	0.09		0.28	0.36
	Wrist Extension	0.40	0.56	0.27	0.43	0.24		0.47	0.42
	Finger Extension	0.74	0.66	0.74	0.74	0.67		0.82	0.82
	Finger Flexion	0.69	0.73	0.79	0.76	0.72		0.84	0.78
	Thumb Flexion	0.63	0.66	0.72	0.72	0.68		0.82	0.74
	Finger Abduction	0.67	0.70	0.70	0.66	0.65		0.83	0.71
	Interosseus Muscle I	0.64	0.67	0.68	0.66	0.65		0.77	0.67
	Thumb Adduction	0.58	0.65	0.63	0.63	0.56		0.74	0.63
	Thumb Opposition	0.55	0.61	0.70	0.67	0.61		0.72	0.66
Savic et al. 2007 Prospective observational MMT scale version unknown National Spinal Injuries Centre, Stoke Mandeville	N=45 (38M, 7F) Mean age 40.3 (Range = 18~72) Post-injury time: 3 mth ~ 43 yrs AIS-A/B/C/D: 24/4/4/13 Cervical/Thoracic/Lumbar: 15/29/1								

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Hospital, Buckinghamshire Hospitals NHS Trust, UK				
Beninato et al. 2004

Retrospective review
Study used Daniels and Worthingham's MMT scale

Acute rehabilitation hospitals, Boston, MA, USA | N=20 (16M, 4F) Mean age 36.8±13.4yrs (range 18-62yrs

Inpatients at one of 2 acute rehab hospitals in Boston, MA. 7 C5, 11 C6, 2 C7 13 AIS A, 6 AIS B, 1 anterior cord syndrome

Admitted to rehabilitation within 1 year of injury

Excluded incomplete individuals with abdominal or lower extremity MMT scores of ≥2. | *MMT scores were compared to FIM scores (all data taken from time of discharge).*

Spearman's rank correlations.

Manual Muscle Test: Elbow flexion and 10 of 12 FIM tasks: $\rho=0.48-0.75$ Shoulder flexion and 8 of 12 FIM tasks: $\rho=0.45-0.72$ Wrist extension and 7 of 12 FIM tasks: $\rho=0.52-0.64$ Elbow extension and 6 of 12 FIM tasks: $\rho=0.57-0.69$ | | |

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		Wrist flexion and 5 of 12 FIM tasks: ρ=0.56-0.73 Shoulder extension and 2 of 12 FIM tasks: ρ=0.59-0.76 Significance at p<0.05 for all. The strongest correlations existed between left shoulder extension and bladder management (0.76), elbow flexion to toileting (0.75), wrist flexion to toilet/tub/shower transfers (0.73), and shoulder flexion and right shoulder extension to dressing upper body (0.71 and 0.72, respectively). No significant correlations were		

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		found between any MMT muscle group and the FIM task of locomotion (wheelchair).		

Fujiwara et al. 1999
 	
Cross-sectional Study used Daniels and Worthingham's MMT scale
 	
Subjects recruited from National Murayama Hospital (1995-1997)
	N=14 (12M, 2F) C6 complete tetraplegic patients Mean age: 30.7 (13~62) Mean time since SCI: 462 (169~1080) days	Spearman's rho btwn total shoulder strength score* and:
		    FIM motor score: 0.95 (P<0.001)
		    FIM transfer score: 0.93 (P<0.001)
		
		Total shoulder strength score is defined as the sum of MMT scores for:
		    Bilateral scapular abduction
		    Upward rotation
		    Shoulder vertical adduction
		    Shoulder extension		

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Noreau & Vachon 1998 Methodological study. Comparison of three methods for measuring upper limb muscle strength in individuals with SCI: the manual muscle test (MMT), the hand-held myometry and the isokinetic dynamometry (Cybex). Study used an adaptation of Medical Research Council's MMT scale	N=38 (31M, 7F) Paraplegia group: (N=23) mean age = 28.2±13.9yrs 18M 5F AIS level at admittance: A-15, B-3, C-1, D-4 Mean DOI at admittance: 1.6±0.7mo Tetraplegia group: (N=15) mean age = 30.1±13.4yrs 13M 2F AIS level at admittance: A-6, B-6, C-3, D-0 Mean DOI at admittance: 2.1±2.1mo	*Measured elbow extension and flexion, shoulder extension and flexion, and shoulder adduction and abduction. The three tests were separated by at least one day and were all performed within a week.* *Modified Manual muscle test (MMT) – graded from 0 to 5* *Hand-held myometer (HHM) – avg of three trials for each muscle group* **Spearman correlations for comparison of MMT and HHM.** Paraplegics r=0.26-0.67 Tetraplegics r=0.50-0.95		

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Rehabilitation Institute (Quebec City)		Highest correlations were for elbow extension and shoulder flexion and adduction in tetraplegics at admittance (r=0.95, 0.83, 0.84, respectively). The majority of correlations decreased at time of discharge. Spearman correlation coefficients between the strength values measured by MMT and myometry for six muscle groups (tested on both sides) in individuals with SCI (n=38): Please see Table 3 below.		

Table 3

	Paraplegia (n=23)	Tetraplegia (n=15)

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	Muscles:	**Admittance**	**Discharge**	**Admittance**	**Discharge**
	Elbow flexors	0.48	0.26**	0.58	0.48*
	Elbow extensors	0.46	0.55	0.95	0.88
	Shoulder flexors	0.63	0.60	0.83	0.50*
	Shoulder extensors	0.44*	0.49	0.67	0.57
	Shoulder abductors	0.64	0.57	0.55*	0.59
	Shoulder adductors	0.67	0.34*	0.84	0.73

*.001<P<.05

**P=.084

P<=0.001 if not indicated

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[Herbison et al.](#) 1996 Cross-sectional Regional Spinal Cord Injury Center of the Delaware Valley 1988-1993	N=88, 78M/10F Mean age 34 Level of injury C4-8. Frankel grades A-D			**Responsiveness:** MMT score may not show significant change in muscle strength while a handheld myometer showed a significant increase in strength for patients with initial MMT score of 4 or greater.
[Schwartz et al.](#) 1992	N=122 Ages 15~70	Spearman's rho between modified		

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Prospective Study used a modified MMT scale, based on that of: Brunnstrom and Dennen, Medical Research Council, Daniels and Worthingham	C4-C6 tetraplegia patients Frankel grades A-D	MMT and Myometry at various post-SCI times (N=15~33): Please see Table 4 below.		

Table 4

	72 Hours	1 Week	1 Month	3 Months	6 Months	12 Months
L. Bicep	0.86	0.84	0.68	0.82	0.59	0.42*
R. Bicep	0.80	0.83	0.79	0.68	0.59	0.18*
L. ECR	0.92	0.86	0.81	0.84	0.84	0.77
R. ECR	0.94	0.78	0.93	0.79	0.75	0.71

ECR = Extensor Carpi Radialis
*P>0.001

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