

**GRADED\_MATCH\_FWD  
SmartWheel Push**

**GRADED\_MATCH\_REV  
RoWheel**

**GRADED\_MATCH\_REV  
SmartWheel Pull**

**STUDY OBJECTIVE**

0 subjects with paraplegia from SCI who use a wheelchair for at least 50% of their community mobility and are free of shoulder pain as evidenced by a score of 10 or less on the Wheelchair User's Shoulder Pain Index will be enrolled.

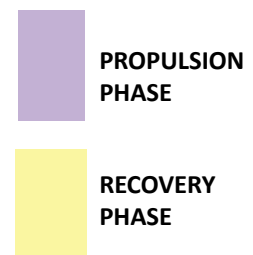
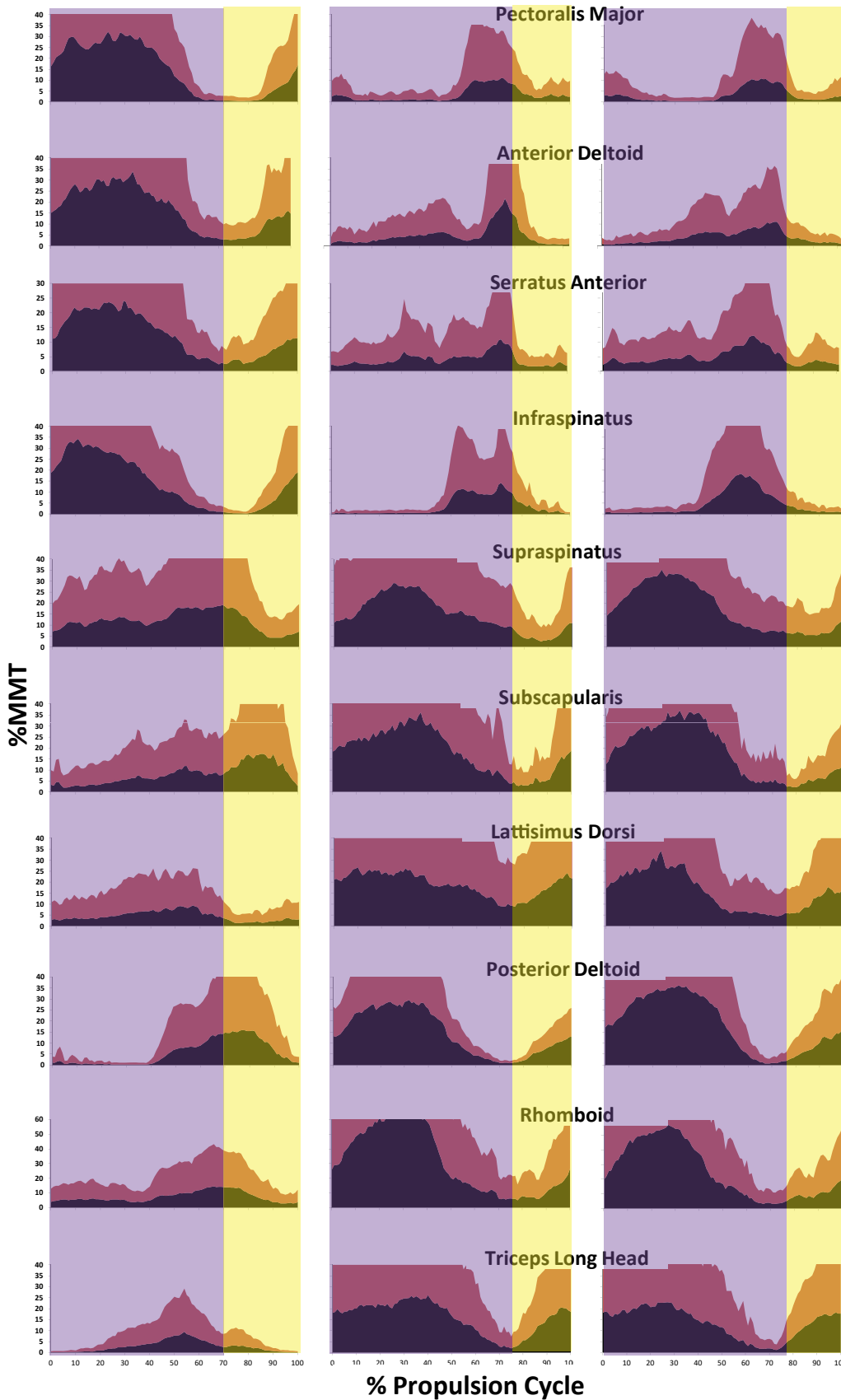
During laboratory testing, participants perform wheelchair propulsion in their own wheelchair that has been secured on a roller resistance unit (wheelchair ergometer) at their usual free and fast rates and with increased resistance to simulate incline propulsion.

Users were asked to perform these propulsion tasks in three conditions:

- pushing forward on the rim of a SmartWheel, a special force sensing wheel which otherwise is similar to a standard push rim, that has been fitted to their wheelchair,
- pulling backward on the rim of the SmartWheel
- pulling backward on the Rowheels rims that have been attached to their wheelchair. Motion of the shoulders and trunk and electromyographic muscle activity of 10 major shoulder muscles will be compared during all 3 propulsion conditions (SmartWheel forward, SmartWheel backward, and Rowwheel backward)

Forces exerted on the push rim were compared during the SmartWheel pushing forward and pulling backwards trials.

EMG (fine wire) muscle activity was recorded during the propulsion phase of the Anterior, Triceps, and posterior deltoids, serratus anterior, rhomboid, Latissimus Dorsi, supraspinatus, Pectoralis Major, infraspinatus, and subscapularis.



PI: Dr. Sara Mulroy and Dr. Phil Requejo (Co-PI)  
Pathokinesiology Lab  
Rancho Los Amigos National Rehabilitation Center, Los Angeles CA

Peak EMG for Matched Speed Inclined Propulsion

(% Maximal Effort) Mean (SD)

	SmartWheel Push	Rowheel	SmartWheel Pull	F	P
Pectoralis Major	55.08* (22.08)	30.52* (20.56)	25.71* (20.95)	27.124	.000
Anterior Deltoid	56.46 (65.21)	39.36 (65.38)	26.49 (20.30)	2.494	.111
Serratus Anterior	43.81 (34.47)	33.77 (24.37)	30.97 (21.69)	3.818	.041
Infraspinatus	54.51 (26.59)	39.23 (16.55)	39.32 (24.38)	2.629	.100
Supraspinatus	43.44 (15.00)	51.48 (19.04)	53.70 (22.78)	3.607	.048
Subscapularis	42.97 (19.78)	55.39 (24.74)	56.59 (25.43)	2.507	.131
Latissimus Dorsi	22.18* (13.50)	64.82* (25.93)	71.13* (45.55)	12.774	.000
Posterior Deltoid	31.18# (18.66)	46.42 (30.22)	56.63# (27.47)	3.628	.047
Rhomboids	36.23* (14.55)	92.58* (58.72)	80.60* (45.82)	11.479	.001
Triceps	20.61* (13.79)	53.26* (24.82)	51.10* (22.71)	28.260	.000

Mean EMG for Matched Speed Free Propulsion

(% Maximal Effort) Mean (SD)

	SmartWheel Push	Rowheel	SmartWheel Pull	F	P
Pectoralis Major	26.21* (9.71)	15.72* (10.59)	13.42* (10.31)	24.783	.000
Anterior Deltoid	23.56# (21.23)	12.54# (9.38)	12.00 (6.73)	4.281	.030
Serratus Anterior	20.18 (13.18)	15.00 (5.24)	14.73 (6.19)	3.357	.058
Infraspinatus	25.02 (11.61)	19.84 (6.61)	20.24 (10.53)	1.409	.270
Supraspinatus	19.71 (6.14)	24.67 (10.62)	25.11 (11.97)	3.874	.040
Subscapularis	18.50 (5.07)	26.18 (10.55)	25.94 (11.66)	4.800	.035
Latissimus Dorsi	12.43* (7.74)	26.80* (10.57)	27.62* (13.88)	9.113	.002
Posterior Deltoid	16.60# (11.04)	22.90 (15.29)	27.34# (13.17)	2.874	.083
Rhomboids	16.90* (6.95)	45.49* (27.46)	37.82* (21.33)	14.327	.000
Triceps	11.02 (7.21)	24.09 (10.58)	23.15 (9.94)	32.741	.000

Duration of Active EMG for Matched Speed Free Propulsion

(% Cycle) Mean (SD)

	SmartWheel Push	Rowheel	SmartWheel Pull	F	P
Pectoralis Major	52.15* (10.85)	14.15* (9.70)	14.82* (13.45)	77.368	.000
Anterior Deltoid	61.26* (15.04)	24.12* (26.55)	23.95* (20.63)	51.328	.000
Serratus Anterior	51.71* (19.94)	22.48* (16.33)	26.11# (14.60)	8.143	.003
Infraspinatus	54.87* (6.60)	16.00* (7.06)	17.55* (9.54)	194.313	.000
Supraspinatus	59.63 (27.07)	55.23 (22.38)	61.97 (25.17)	.377	.691
Subscapularis	41.18 (13.01)	59.81 (26.24)	60.85 (20.93)	2.961	.098
Latissimus Dorsi	28.80* (26.89)	62.95* (30.57)	55.29* (25.39)	14.994	.000
Posterior Deltoid	26.44* (14.94)	52.24* (21.82)	62.91* (13.57)	18.208	.000
Rhomboids	40.84* (22.99)	65.91* (19.29)	64.39* (14.61)	12.358	.001
Triceps	16.39* (10.61)	57.93* (23.01)	51.70* (20.94)	51.692	.000

Intensity\*Duration Intergal of EMG for Matched Speed Free Propulsion

(% Max\* % Cycle) Mean (SD)

	SmartWheel Push	Rowheel	SmartWheel Pull	F	P
Pectoralis Major	1400.81* (634.48)	292.41* (309.58)	280.29* (345.74)	51.482	.000
Anterior Deltoid	1650.19 (2172.79)	454.18 (682.63)	355.39 (333.82)	4.927	.020
Serratus Anterior	1210.16# (1085.31)	357.65# (284.71)	413.26# (329.79)	7.300	.005
Infraspinatus	1408.64* (744.74)	338.41* (218.77)	431.89* (339.16)	21.847	.000
Supraspinatus	1188.47 (615.75)	1469.49 (944.04)	1704.50 (1058.88)	2.844	.084
Subscapularis	782.71 (356.64)	1786.61 (1093.73)	1739.86 (1028.47)	6.548	.015
Latissimus Dorsi	389.41* (454.22)	1876.04* (1290.09)	1537.57* (906.01)	11.721	.001
Posterior Deltoid	550.40* (379.08)	1429.95* (1071.19)	1803.45* (1035.09)	7.727	.004
Rhomboids	731.36* (448.22)	3166.42* (1902.22)	2529.52* (1456.23)	17.326	.000
Triceps	234.82* (189.91)	1586.63* (992.16)	1318.28* (831.43)	22.819	.000