Carpal Tunnel Syndrome and Manual Wheelchair *Pushers*

Studies evaluating the prevalence of Carpal Tunnel Syndrome (CTS) in the manual wheelchair population have found the incidence to be between 49% and 63% (1, 2, 3). In all of these studies the repetitive task of propelling a wheelchair was implicated in the development of CTS.

Push Propulsion and Carpal Tunnel Syndrome

The fundamental pathophysiology behind the development of CTS is injury to the median nerve within the carpal canal. Median nerve damaged has been associated with high-force, and large wrist range of motion (ROM) (4, 5). In particular, the rate of rise force applied at the beginning of the push propulsive stroke (initial impacting of the handrim) is the variable most significantly related to median nerve function and development of CTS (6). In push propulsion the higher rate of rise in force and largest wrist ROM occur approximately at the same time (B), compounding the amount of pressure into the carpal canal.

Push Propulsion vs Rowheeling Study Results

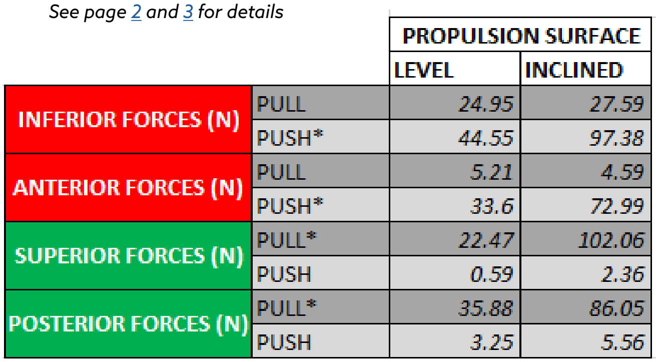
A recent study comparing Rowheeling/pull and push propulsion measured forces at the handrim, which are indicative of the forces experienced at the wrist. The inferior and anterior forces, which put the wrist into compression, were substantially larger in push propulsion than in PULL propulsion (7). Moreover, comparing level surface and inclined propulsion showed that while these inferior and anterior forces doubled during inclined push propulsion they virtually stayed the same during PULL propulsion. The superior and posterior forces, which put the wrist into tension (reducing compression), were substantially larger during PULL propulsion. During free/level surface propulsion the posterior forces were 11 times larger and superior forces were 38 times larger during PULL propulsion, increasing to 15 times larger and 43 times larger respectively during graded/incline propulsion.

Rowheeling and Carpal Tunnel Syndrome

Due to the biomechanics involved, Rowheeling/PULL propulsion could substantially reduces the forces that can cause CTS. Thus, one can infer that the rate of rise forces at the beginning of the PULL strokes (A) are less harmful than the rate of rise forces at the beginning of push strokes (B). The kinematics of PULL propulsion are such that during the initial phases of the PULL propulsion stroke, where the forces are largest, the wrist angle/ROM is the smallest (A). The wrist range of motion is largest at the end of the PULL propulsion stroke (B), where the PULL propulsion forces are lower.

STUDY RESULTS: HANDRIM FORCES

See page 2 and 3 for details

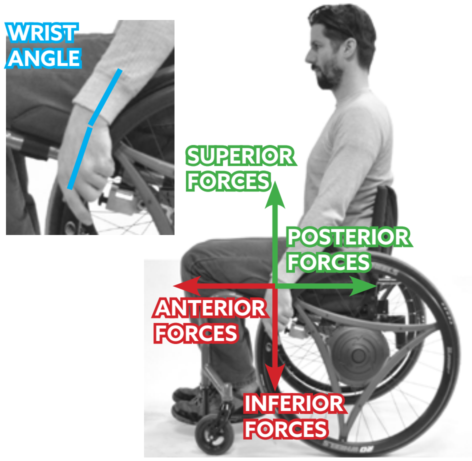


		PROPULSION SURFACE	
		LEVEL	INCLINED
INFERIOR FORCES (N)	PULL	24.95	27.59
	PUSH*	44.55	97.38
ANTERIOR FORCES (N)	PULL	5.21	4.59
	PUSH*	33.6	72.99
SUPERIOR FORCES (N)	PULL*	22.47	102.06
	PUSH	0.59	2.36
POSTERIOR FORCES (N)	PULL*	35.88	86.05
	PUSH	3.25	5.56

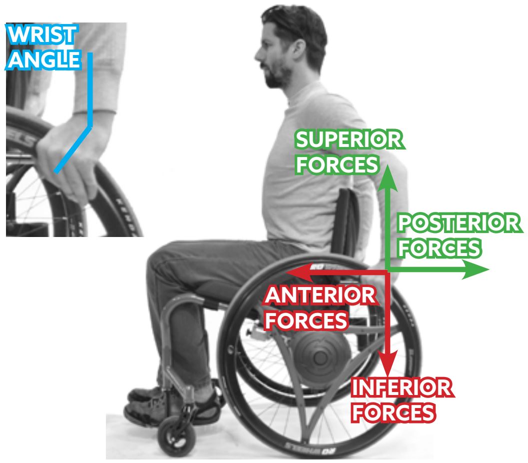
*larger in comparison

READ STUDY

A) Beginning of Pull Stroke/ End of Push Stroke

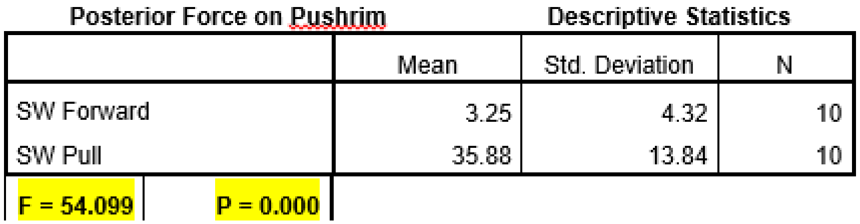


B) Beginning of Push Stroke/ End of Pull Stroke



Level Ground Handrim Forces: Smartwheel Pushing versus Smartwheel Pulling

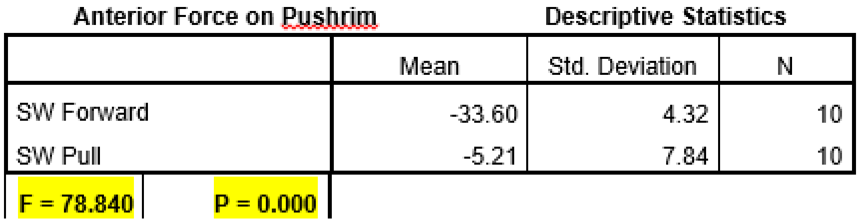
Forward (ANTERIOR) and downward (INFERIOR) forces on the handrim are significantly greater during push propulsion than in pulling (45 vs 25 newtons for downward force and 34 vs 5 newtons for forward force).   In contrast, backward (POSTERIOR) and upward (SUPERIOR) forces on the handrim are significantly greater during pulling propulsion than in pushing (22 vs 1 newtons for upward force and 36 vs 3 newtons for backward force). Medial and lateral forces on the pushrim are not different in the two conditions.



Posterior Force on Pushrim **Descriptive Statistics**

	Mean	Std. Deviation	N
SW Forward	3.25	4.32	10
SW Pull	35.88	13.84	10

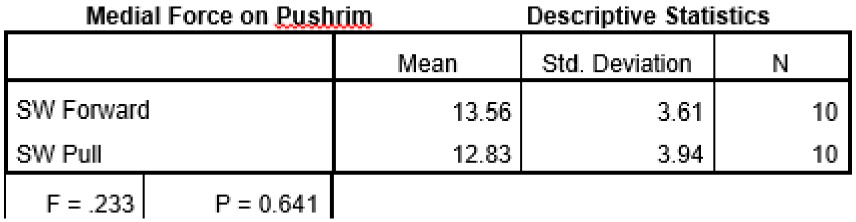
F = 54.099 **P = 0.000**



Anterior Force on Pushrim **Descriptive Statistics**

	Mean	Std. Deviation	N
SW Forward	-33.60	4.32	10
SW Pull	-5.21	7.84	10

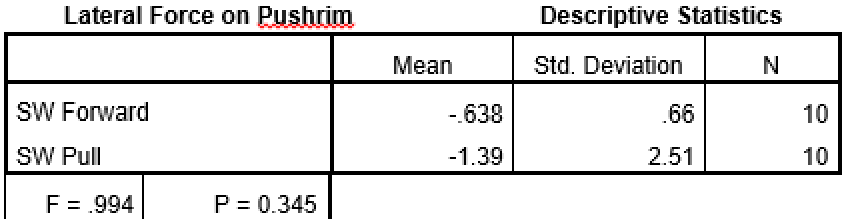
F = 78.840 **P = 0.000**



Medial Force on Pushrim **Descriptive Statistics**

	Mean	Std. Deviation	N
SW Forward	13.56	3.61	10
SW Pull	12.83	3.94	10

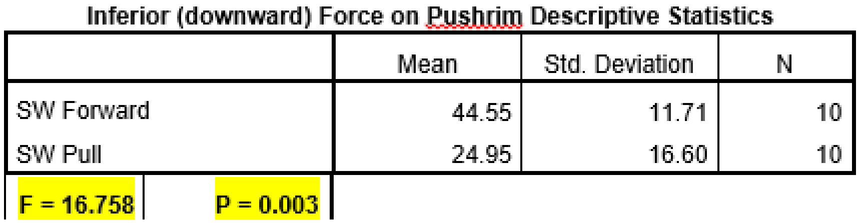
F = .233 P = 0.641



Lateral Force on Pushrim **Descriptive Statistics**

	Mean	Std. Deviation	N
SW Forward	-.638	.66	10
SW Pull	-1.39	2.51	10

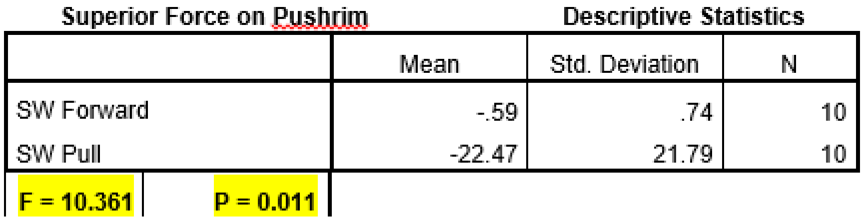
F = .994 P = 0.345



Inferior (downward) Force on Pushrim Descriptive Statistics

	Mean	Std. Deviation	N
SW Forward	44.55	11.71	10
SW Pull	24.95	16.60	10

F = 16.758 **P = 0.003**



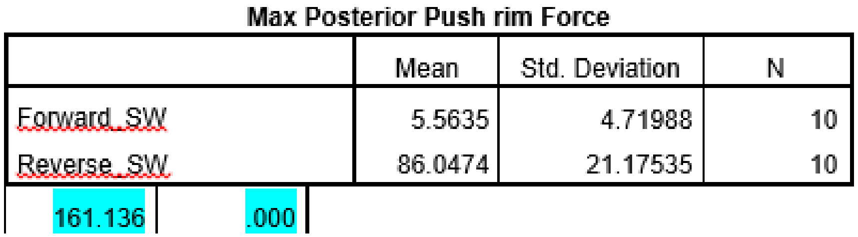
Superior Force on Pushrim **Descriptive Statistics**

	Mean	Std. Deviation	N
SW Forward	-.59	.74	10
SW Pull	-22.47	21.79	10

F = 10.361 **P = 0.011**

Values of P≤0.05 are statistically significant

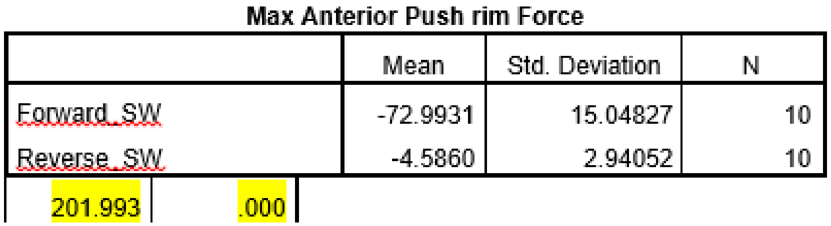
Graded/Incline Handrim Forces: Smartwheel Pushing versus Smartwheel Pulling
Forward (ANTERIOR) and downward (INFERIOR) forces on the handrim are significantly greater during push propulsion than in pulling (97 vs 26 newtons for downward force and 73 vs 5 newtons for forward force). In contrast, backward (POSTERIOR) and upward (SUPERIOR) forces on the handrim are significantly greater during pulling propulsion than in pushing (86 vs 6 newtons for upward force and 102 vs 2 newtons for backward force). Medial and lateral forces on the handrim are not different in the two conditions.



Max Posterior Push rim Force

	Mean	Std. Deviation	N
Forward_SW	5.5635	4.71988	10
Reverse_SW	86.0474	21.17535	10

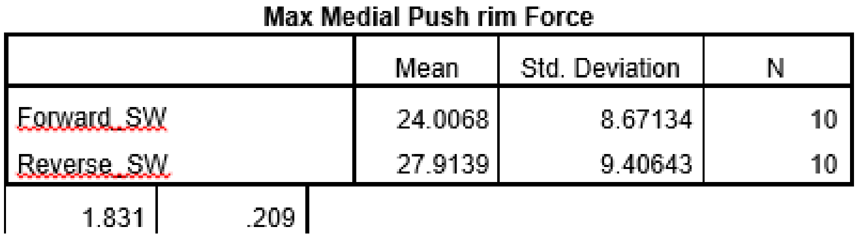
161.136	.000



Max Anterior Push rim Force

	Mean	Std. Deviation	N
Forward_SW	-72.9931	15.04827	10
Reverse_SW	-4.5860	2.94052	10

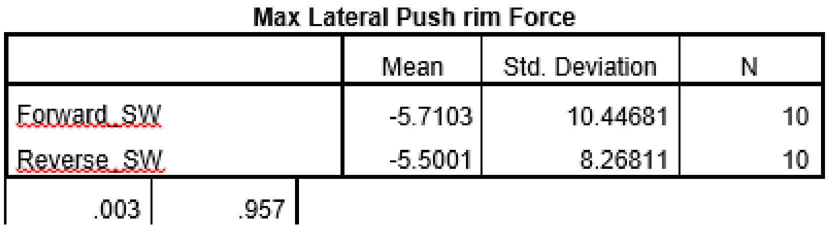
201.993	.000



Max Medial Push rim Force

	Mean	Std. Deviation	N
Forward_SW	24.0068	8.67134	10
Reverse_SW	27.9139	9.40643	10

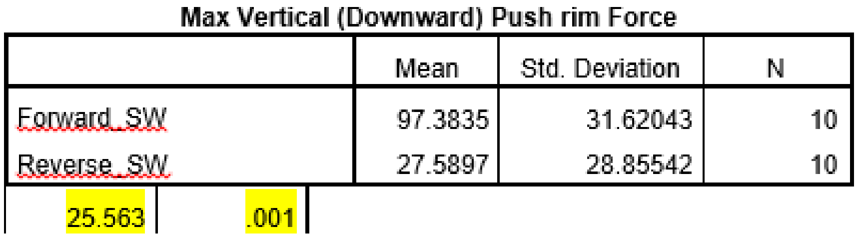
1.831	.209



Max Lateral Push rim Force

	Mean	Std. Deviation	N
Forward_SW	-5.7103	10.44681	10
Reverse_SW	-5.5001	8.26811	10

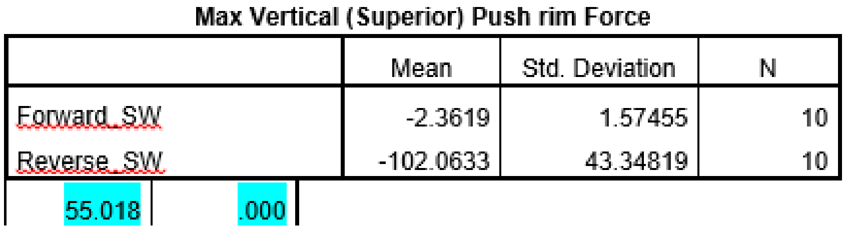
.003	.957



Max Vertical (Downward) Push rim Force

	Mean	Std. Deviation	N
Forward_SW	97.3835	31.62043	10
Reverse_SW	27.5897	28.85542	10

25.563	.001



Max Vertical (Superior) Push rim Force

	Mean	Std. Deviation	N
Forward_SW	-2.3619	1.57455	10
Reverse_SW	-102.0633	43.34819	10

55.018	.000

Values of P≤0.05 are statistically significant