

The effects of an object's height and weight on force calibration and kinematics when post-stroke and healthy individuals reach and grasp

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Table S1: Demographic characteristics of the participants

Participant No.	Age (years)	Gender (M/F)	Time post-stroke (days)	Lesion type (I/H)	Lesion location	Affected side (R/L) (recorded side for control)	Dominant hand tested (Y/N)	FMA score/66	Chedoke score/49
Stroke									
P01	58	M	38	I	MCA	R	Y	56	46
P02	56	M	91	I	MCA	R	Y	36	23
P03	85	F	38	H	MCA	L	N	44	34
P04	62	M	51	I	ACA	L	Y	38	28
P05	80	F	64	I	BG	L	N	48	33
P06	74	F	52	I	MCA	L	N	56	42
P07	55	F	60	I	MCA	L	N	50	41
P08	81	F	26	I	MCA+BG	L	N	46	33
P09	67	M	18	I	MCA+BG	L	N	59	46
P10	79	F	39	I	Cerebellum	R	Y	49	34
P11	82	F	28	I	MCA	L	N	50	38
P12	75	F	29	I	PCA	R	Y	57	45
P13	78	F	42	I	MCA	R	Y	52	41
P14	66	F	38	I	MCA	R	Y	58	44
P15	63	M	34	I	Pons	R	Y	57	45
P16	63	M	71	H	BG	R	Y	33	16
P17	59	M	37	I	MCA	R	Y	35	32
P18	71	M	33	I	MCA	L	N	42	30
P19	59	F	62	I	MCA	R	Y	40	31
P20	59	M	97	H	FL	L	N	30	19
P21	74	M	37	I	BG	L	N	53	42
P22	71	F	27	I	MCA	L	N	62	47
P23	83	M	34	I	MCA	L	Y	33	27
P24	79	M	40	I	MCA	R	Y	59	45
P25	60	F	29	I	MCA	L	N	46	38
P26	80	M	30	I	PCA	R	Y	54	43
P27	64	M	32	I	PCA	L	N	35	19
P28	79	M	76	I	MCA	R	Y	30	22
P29	78	M	56	H	BG	L	N	33	29
P30	70	F	72	I	MCA	R	Y	55	35
Mean ± SD	70.33±9.3	M=53.3% F=46.7%	46.03±11.9	I=86.6% H=13.4%		R=46.6% L=53.4%	Y=53.3% N=46.7%	46.5±10.1	34.9±9.1
Range Healthy Controls	55-85							30-62	16-47
C01	51	F	NA	NA	NA	R	Y	NA	NA
C02	59	F	NA	NA	NA	L	N	NA	NA
C03	85	M	NA	NA	NA	L	N	NA	NA
C04	82	F	NA	NA	NA	R	N	NA	NA
C05	61	F	NA	NA	NA	L	N	NA	NA
C06	66	M	NA	NA	NA	L	N	NA	NA
C07	79	F	NA	NA	NA	R	Y	NA	NA
C08	85	M	NA	NA	NA	R	Y	NA	NA
C09	76	F	NA	NA	NA	R	Y	NA	NA
C10	79	F	NA	NA	NA	R	Y	NA	NA
C11	63	F	NA	NA	NA	R	Y	NA	NA

C12	70	F	NA	NA	NA	R	Y	NA	NA
C13	63	F	NA	NA	NA	R	Y	NA	NA
C14	52	F	NA	NA	NA	L	N	NA	NA
C15	57	M	NA	NA	NA	L	Y	NA	NA
C16	78	M	NA	NA	NA	L	N	NA	NA
Mean ±	69.1±11	M=31.2				R=56.2	Y=56.2		
SD	.6	%				%	%		
		F=68.8				L=43.8	N=43.8		
		%				%	%		
range	51-85								

Abbreviations: P-Patients, C-Control; M-male; F-female; I-ischemic; H-hemorrhagic; MCA-Middle cerebral artery; ACA-Anterior cerebral artery; BG-Basal ganglia; PCA-Posterior cerebral artery; FL-Frontal lobe; NA-Not Applicable; R-right; L-left; Y-yes; N-no; FMA-Fugl-Meyer Assessment; SD-standard deviation.

Time point calculations

In order to analyse the data, the movement was divided into three logical phase: Reaching for the cup, Grasp and Lift. The segments were determined using the following four time points: movement initiation (T1), the time at which the cup was grasped (T2), the time at which the cup was lifted (T3), and the end of the movement, once the cup was placed on the shelf (T4)³⁹. The combinations of the time points produced the phases of movement: Phase 1 “Reach to grasp” (T1 to T2: from starting position until grasp of the cup), Phase 2 “Grasp” (T2 to T3), Phase 3 “Lift” (T3 to T4: from grasp until placing the cup on the shelf), and the whole movement (T1 to T4). First T4 was calculated, then T3, T2 and finally T1. They were calculated as follows: *Movement initiation (T1)*: The speed trace of the wrist movement measured by the wrist sensor was scanned from the start of the recording to T2, when the cup was grasped. T1 was the time at which the wrist speed exceeded 10% of its maximal value during this phase.

- *Cup grasp (T2)*: The maximal value of the force within the first 100 data points on the force trace was calculated ($F_{\text{baseline_max}}$). T2 was the time at which the force trace first reached a value of 0.2 N beyond $F_{\text{baseline_max}}$.
- *Cup lift (T3)*: The trace of the vertical position of the cup was scanned from the start of the recording to T4, and the maximum value was calculated – this was the highest cup location during the movement as measured by the Y component of the rigid body sensor (Y_{max}). The minimal cup height (Y_{min}) was similarly calculated. The vertical distance travelled by the cup $Y_{\text{range}} = Y_{\text{max}} - Y_{\text{min}}$ was then computed, and T3 was taken to be the time at which the cup reached a height equal to 10% of Y_{range} (above Y_{min}).
- *End of movement (T4)*: The first 100 data points on the force trace were averaged, to establish the average baseline force value, and this value was subtracted from the force trace, to remove measurement noise. Then, the maximum value of the force in that movement was calculated (F_{max}). The last time point where the force value was 20% of F_{max} was identified, and the force trace was scanned from that point forward to find the first instance where the force value exceeded 5% of F_{max} . This point was determined as T4.

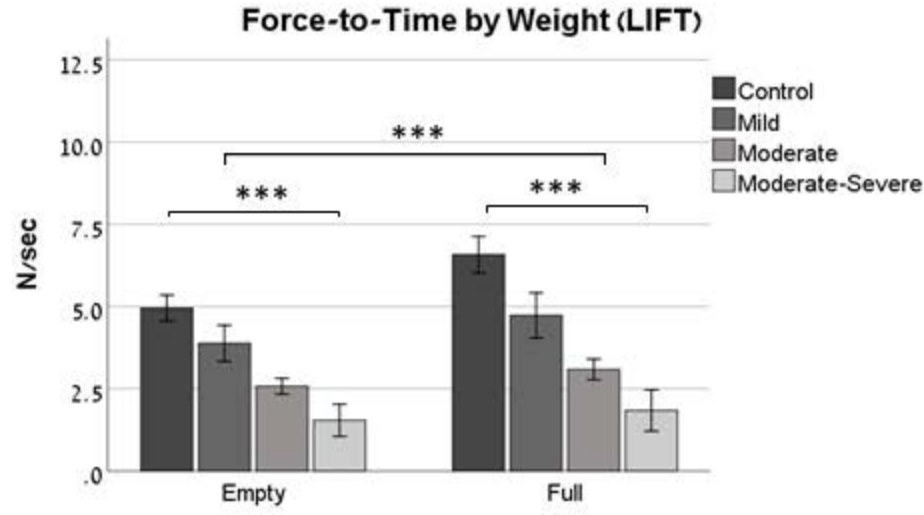
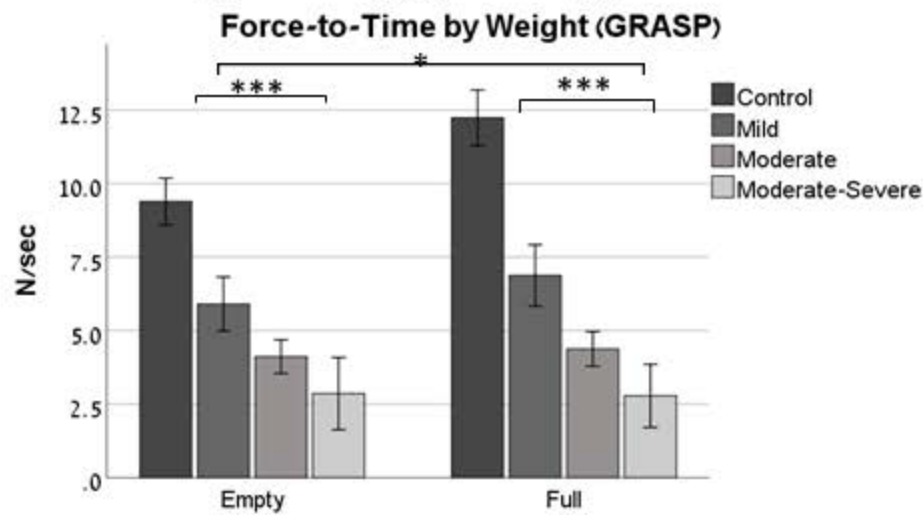
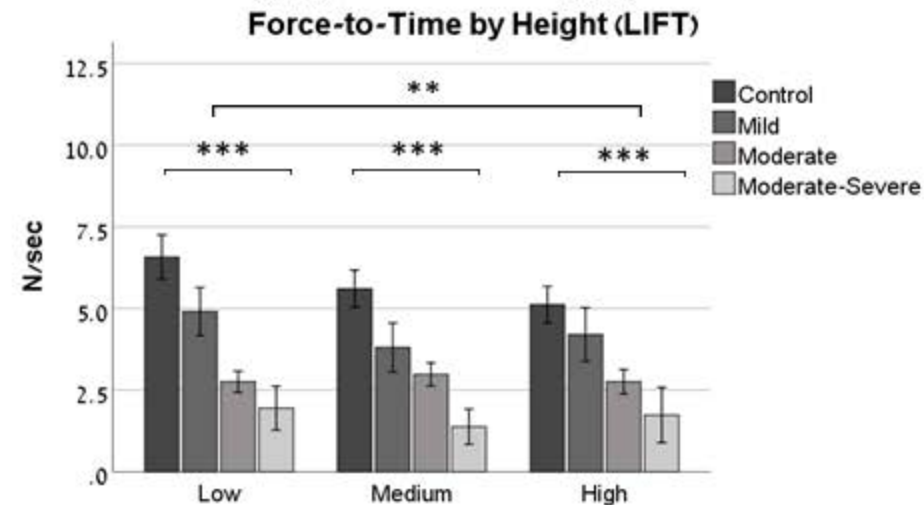
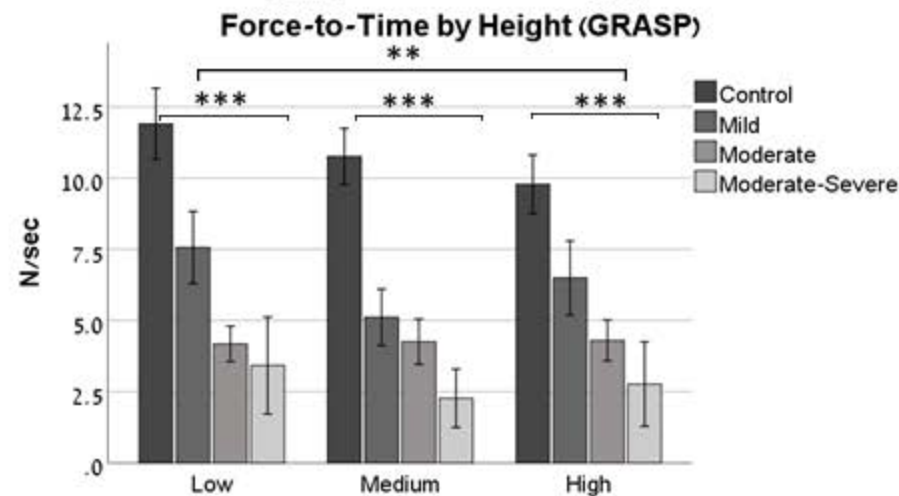
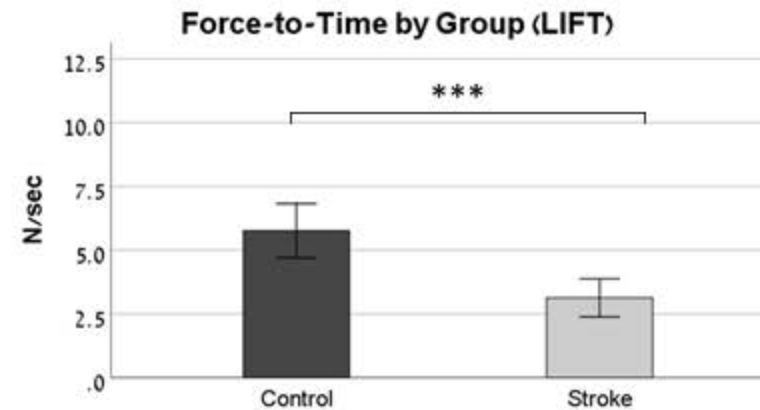
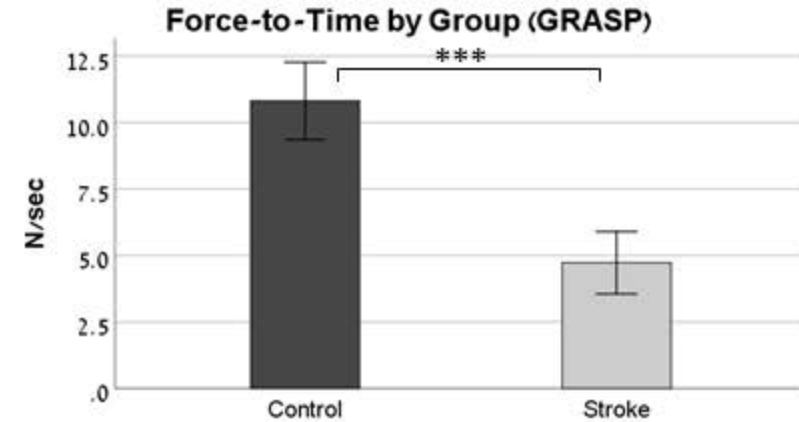
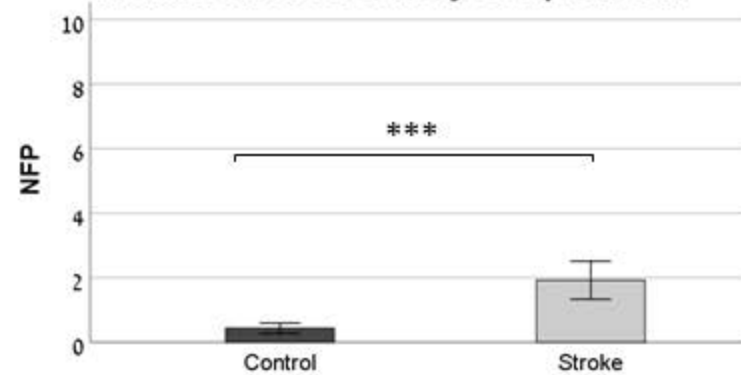
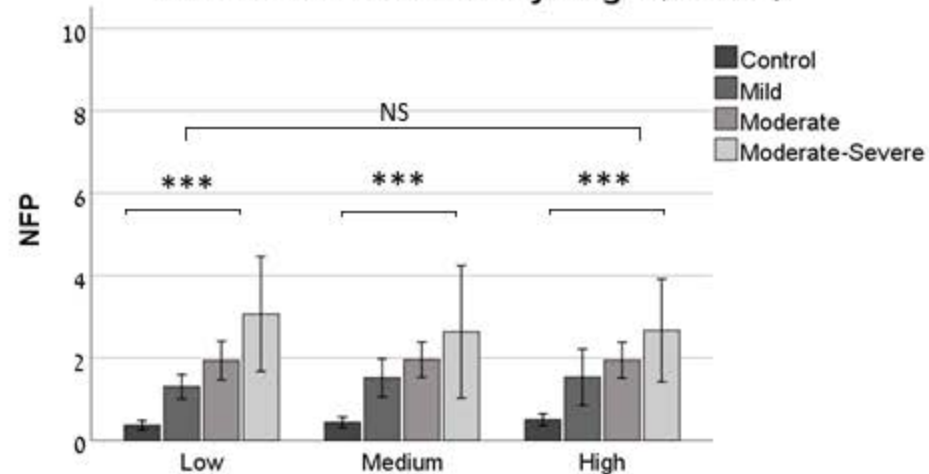


Figure S1. Force-to-time ratio (FTR; N/sec). FTR values for the Grasp phase (*left*), and the Lift phase (*right*). The top row shows the results by group (control/stroke). The middle row shows the results by height (low/medium/high), and by sub-group (control/mild impairment/moderate impairment/moderate-severe impairment). The bottom row shows the results by weight (empty/full cup, corresponding to light/heavy weight), and by sub-group. Asterisks denote the *p*-value: **p*≤0.05, ***p*≤0.01, ****p*≤0.001. Abbreviations: N-Newtons; sec-seconds; NS-not significant

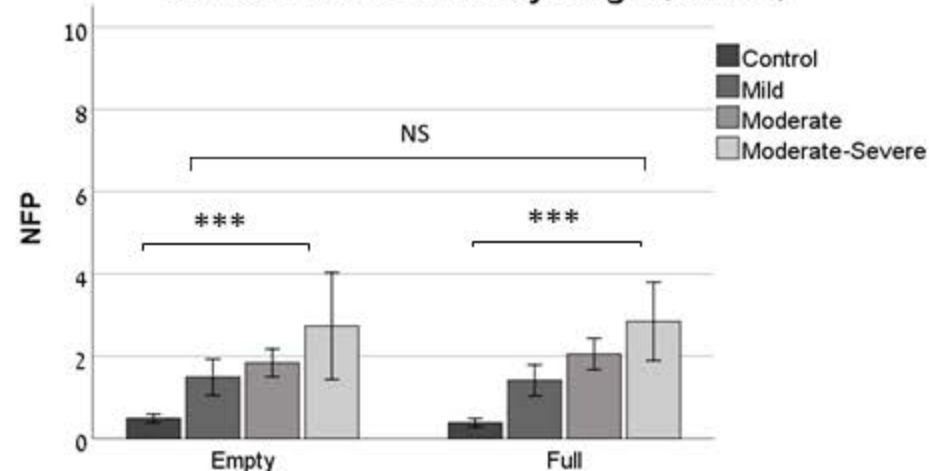
Number of Force Peaks by Group (GRASP)



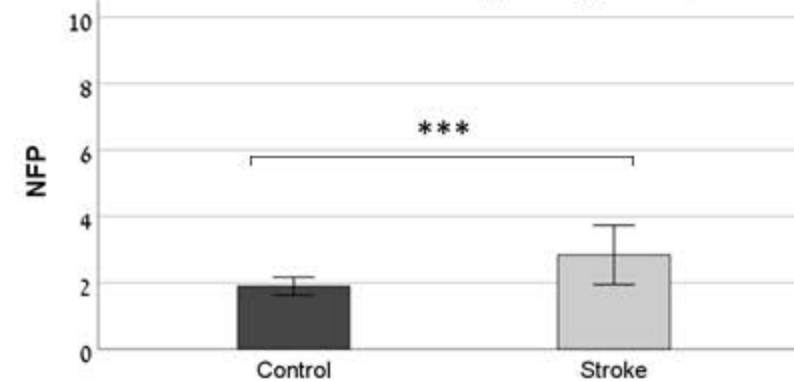
Number of Force Peaks by Height (GRASP)



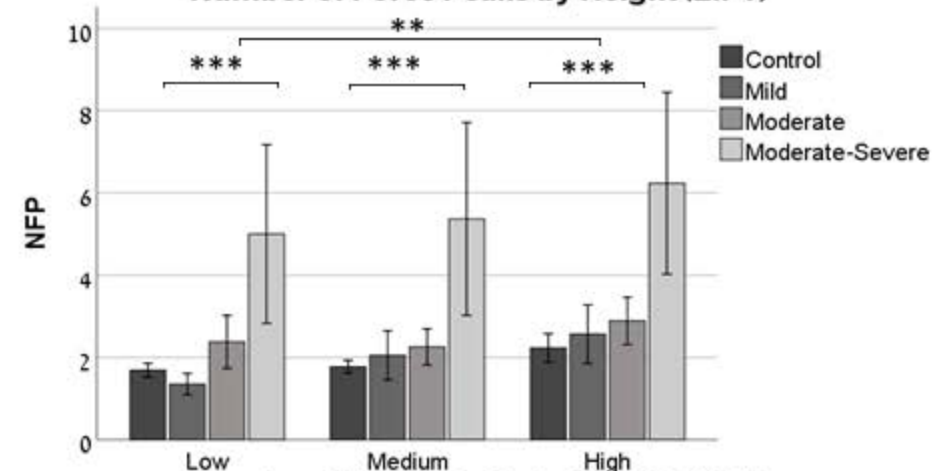
Number of Force Peaks by Weight (GRASP)



Number of Force Peaks by Group (LIFT)



Number of Force Peaks by Height (LIFT)



Number of Force Peaks by Weight (LIFT)

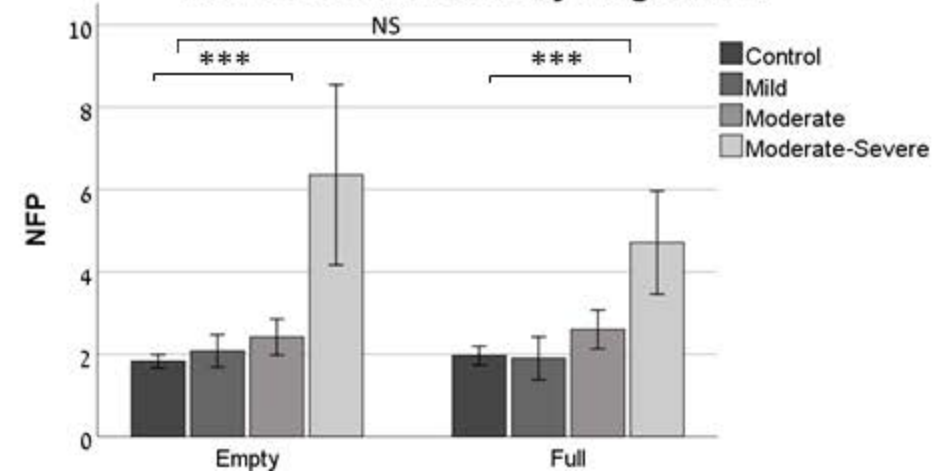
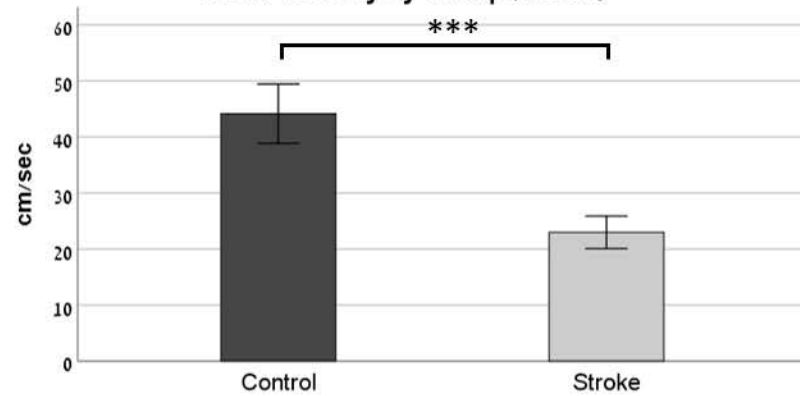
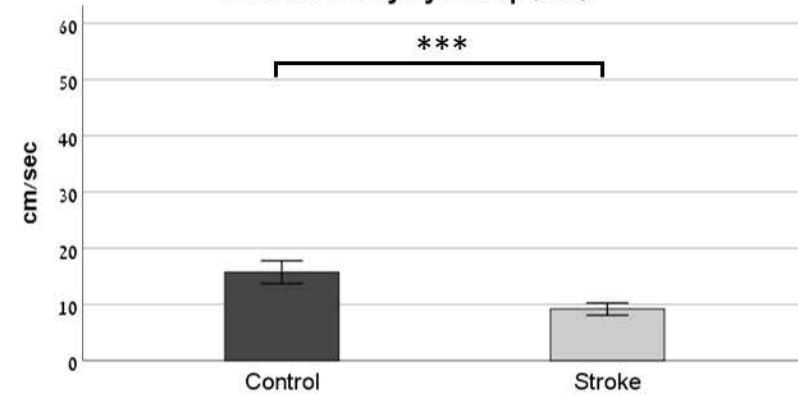


Figure S2. Number of Force Peaks (NFP). NFP values for the Grasp phase (*left*), and the Lift phase (*right*). The top row shows the results by group (control/stroke). The middle row shows the results by height (low/medium/high), and by sub-group (control/mild impairment/moderate impairment/moderate-severe impairment). The bottom row shows the results by weight (empty/full cup, corresponding to light/heavy weight), and by sub-group. Asterisks denote the *p*-value: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$. Abbreviations: NS-not significant.

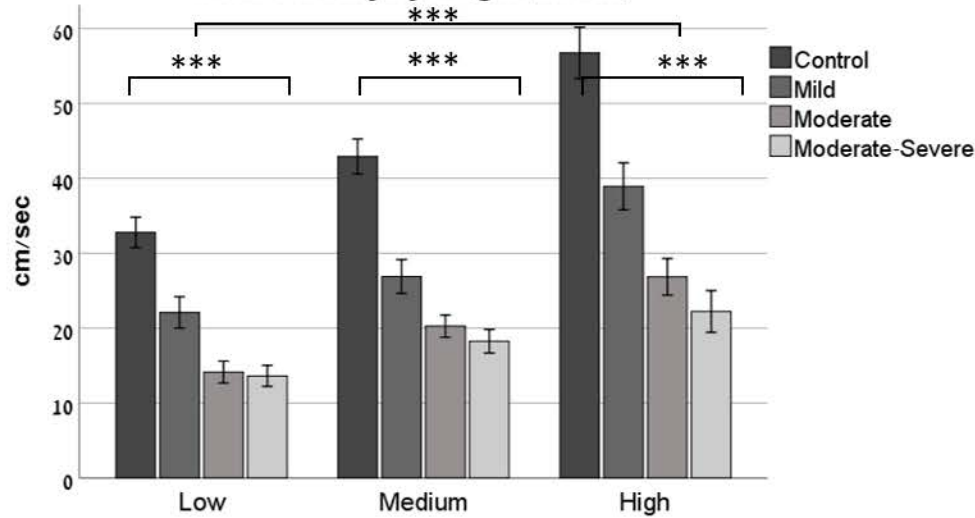
Mean Velocity by Group (Reach)



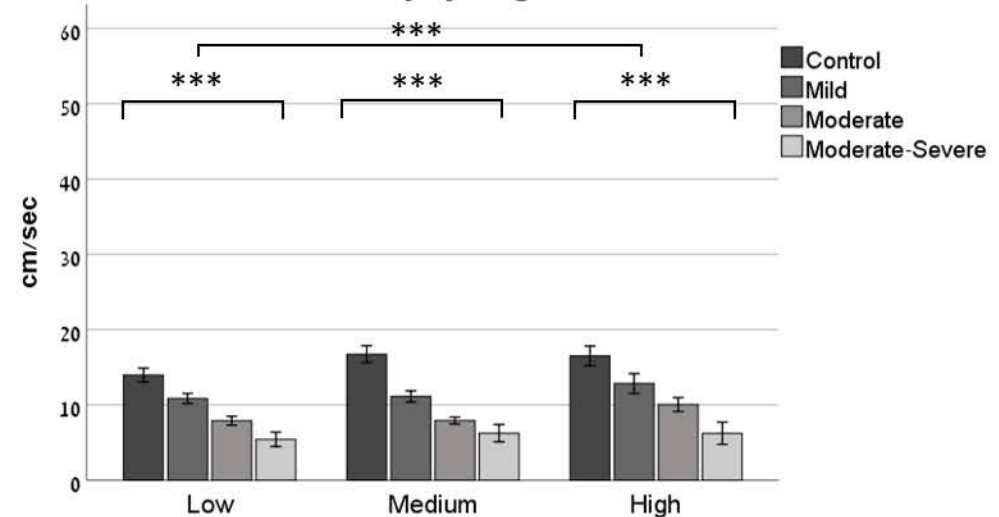
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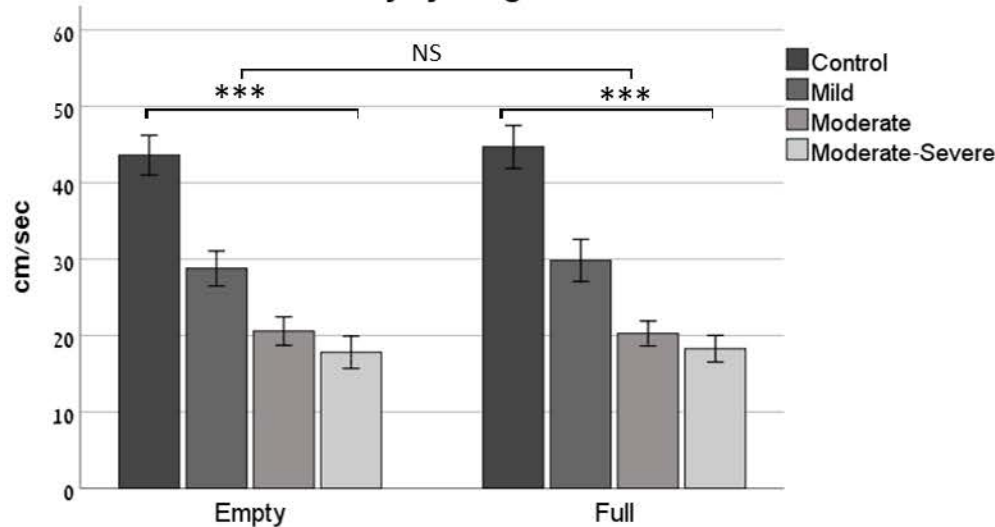
Mean Velocity by Height (Reach)



Mean Velocity by Height (Lift)



Mean Velocity by Weight (Reach)



Mean Velocity by Weight (Lift)

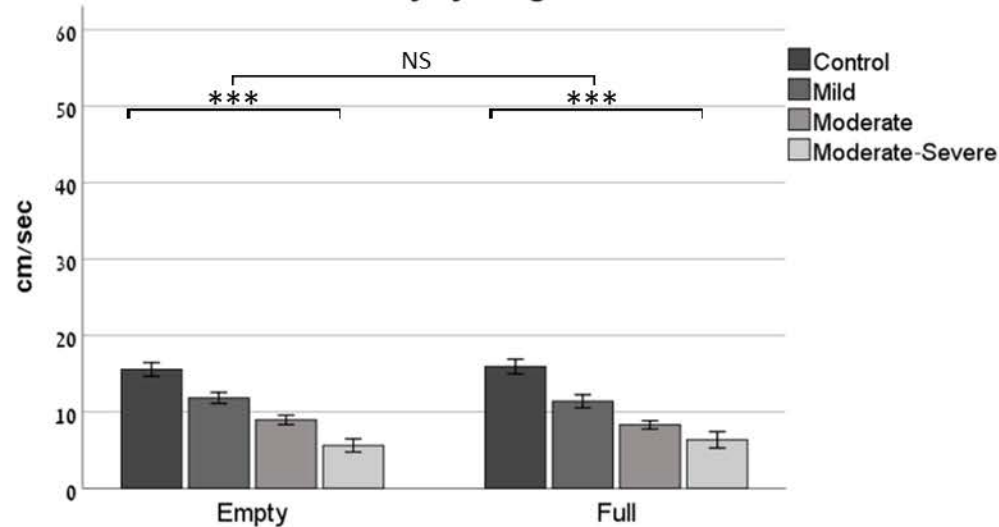
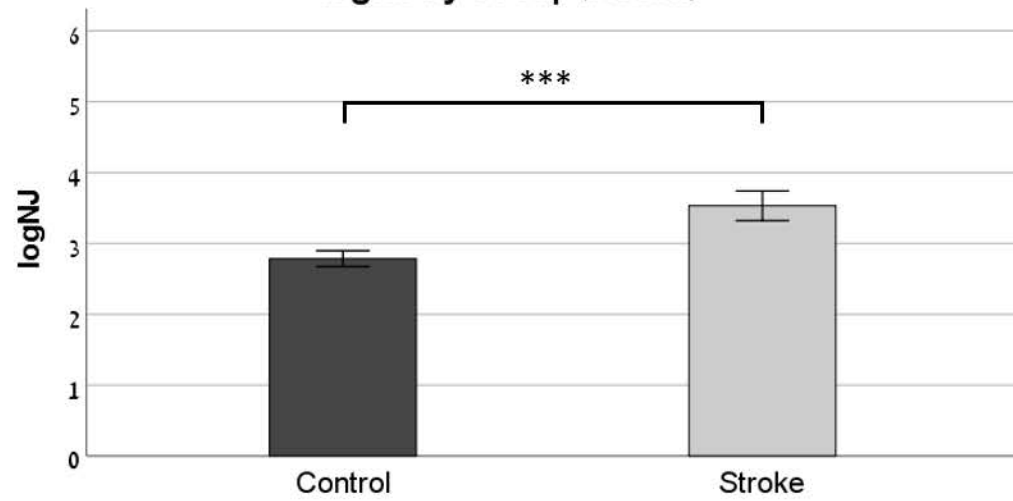
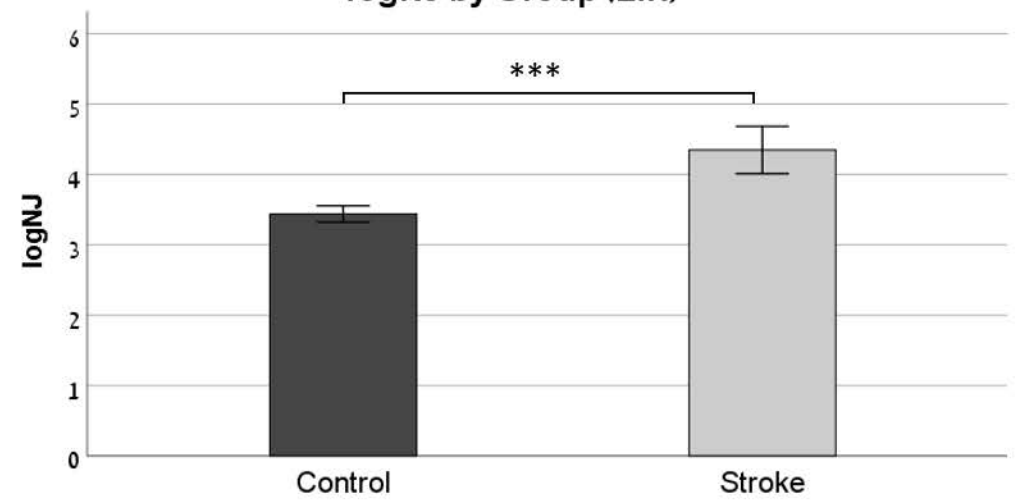


Figure S3. Mean Velocity. Mean velocity values for the Reach phase (*left*), and the Lift phase (*right*). The top row shows the results by group (control/stroke). The middle row shows the results by height (low/medium/high), and by sub-group (control/mild impairment/moderate impairment/moderate-severe impairment). The bottom row shows the results by weight (empty/full cup, corresponding to light/heavy weight), and by sub-group. Asterisks denote the *p*-value: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$. Abbreviations: cm-centimeter; sec-seconds.

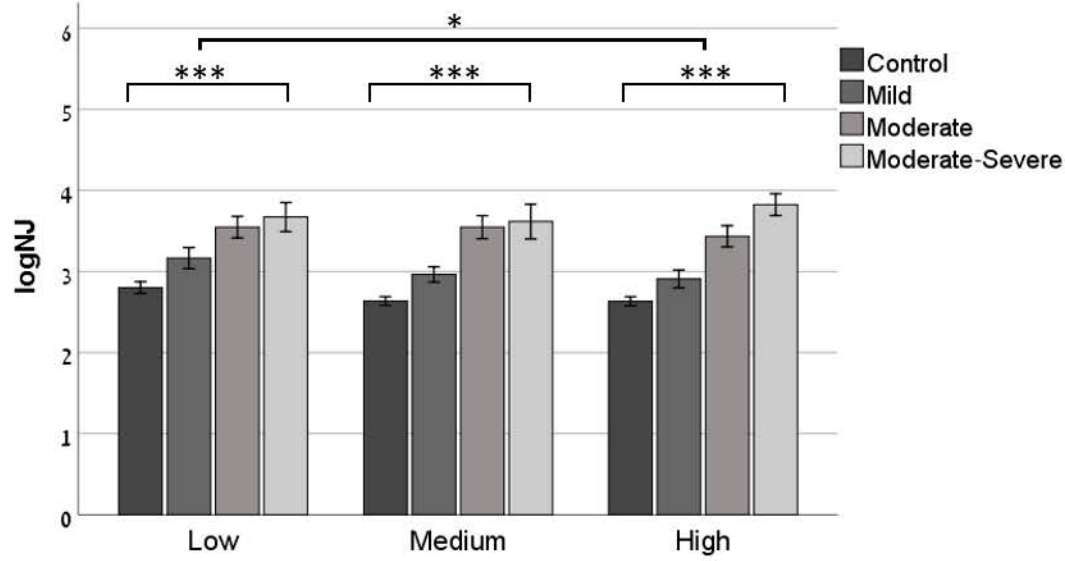
logNJ by Group (Reach)



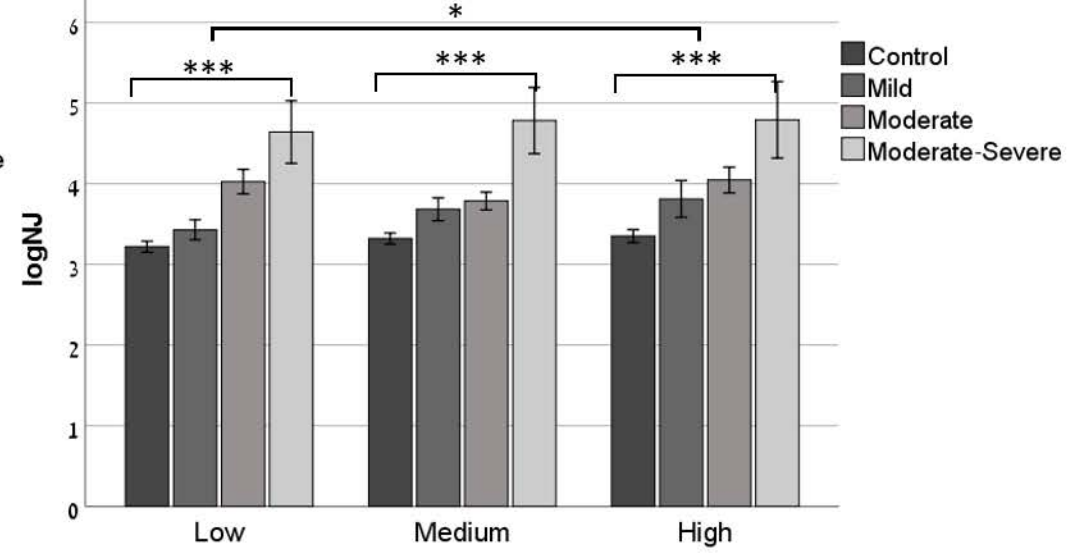
logNJ by Group (Lift)



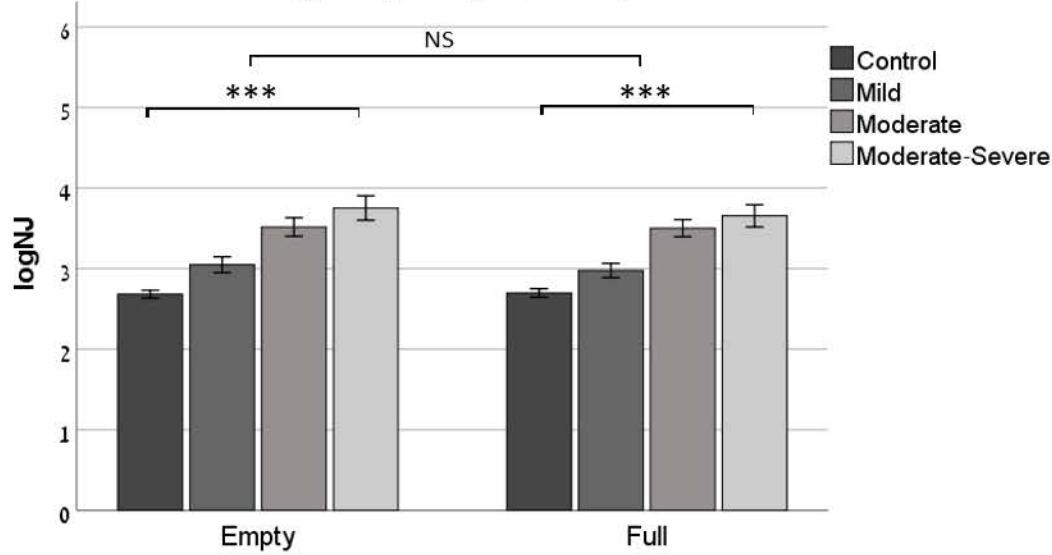
logNJ by Height (Reach)



logNJ by Height (Lift)



logNJ by Weight (Reach)



logNJ by Weight (Lift)

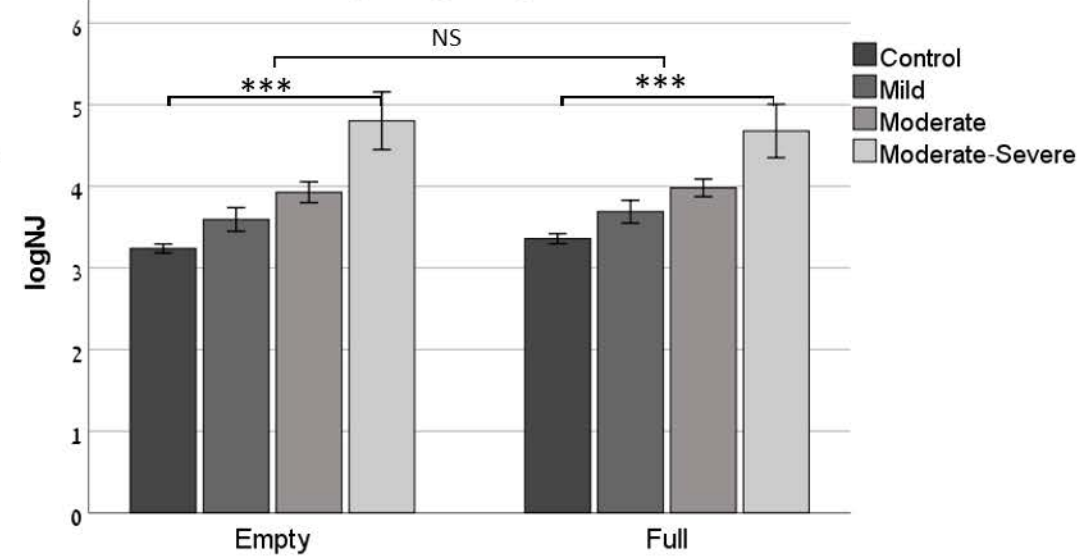
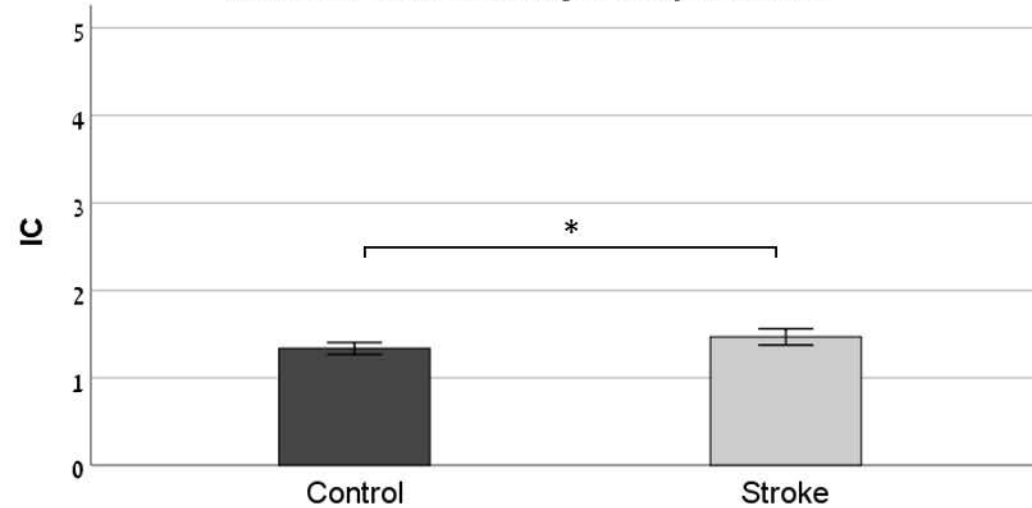
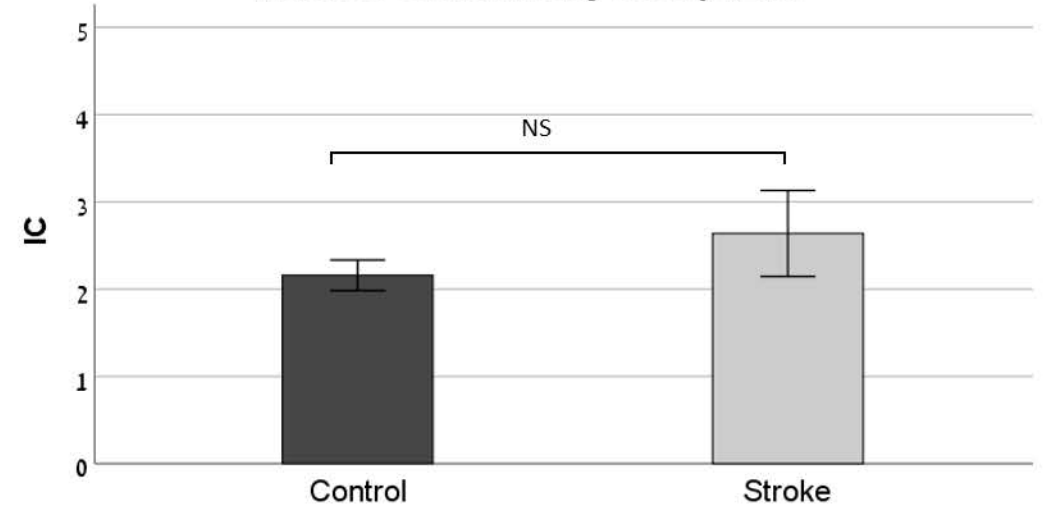


Figure S4. Normalized jerk (NJ). NJ values for the Reach phase (*left*), and the Lift phase (*right*). The top row shows the results by group (control/stroke). The middle row shows the results by height (low/medium/high), and by sub-group (control/mild impairment/moderate impairment/moderate-severe impairment). The bottom row shows the results by weight (empty/full cup, corresponding to light/heavy weight), and by sub-group. Asterisks denote the p -value: * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$ Abbreviations: NS-not significant.

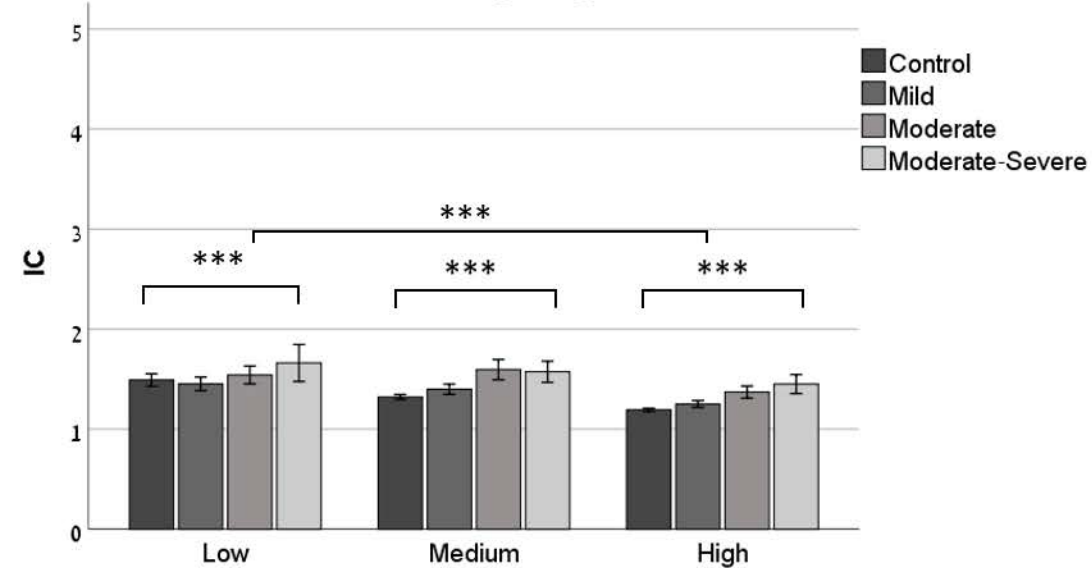
Index of Curvature by Group (Reach)



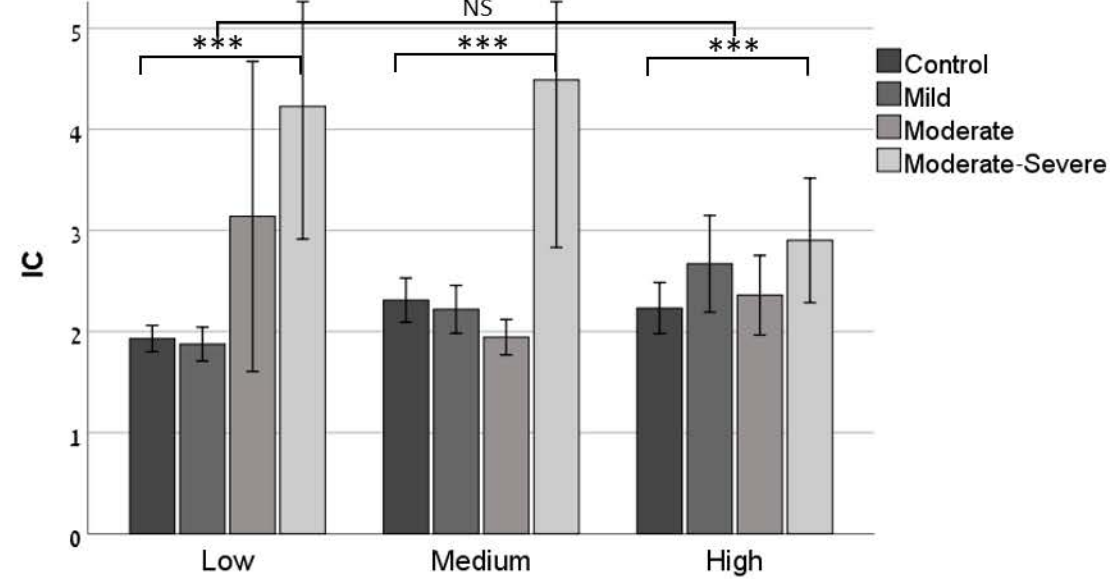
Index of Curvature by Group (Lift)



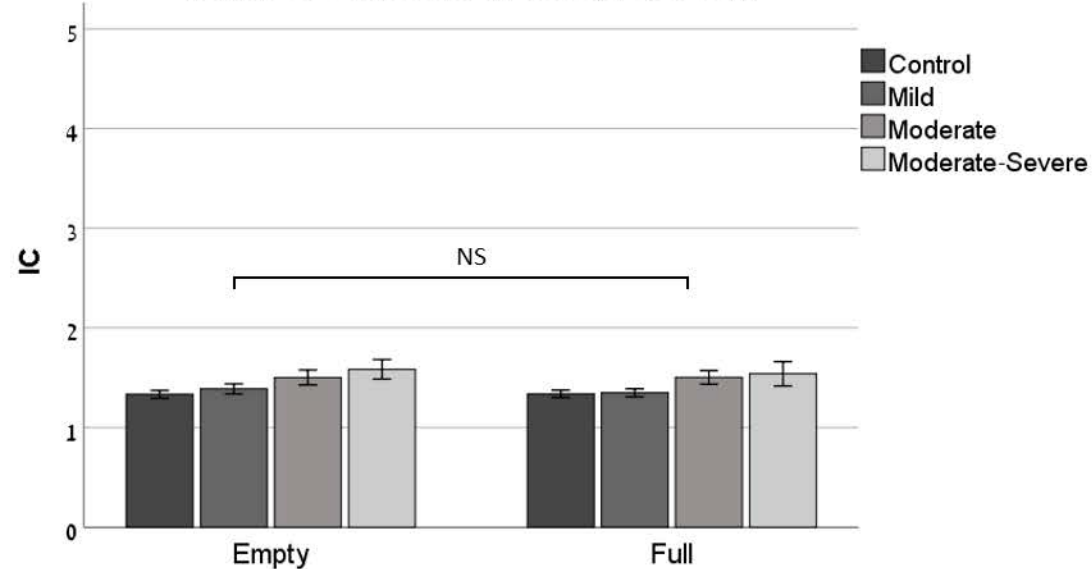
Index of Curvature by Height (Reach)



Index of Curvature by Height (Lift)



Index of Curvature by Weight (Reach)



Index of Curvature by Weight (Lift)

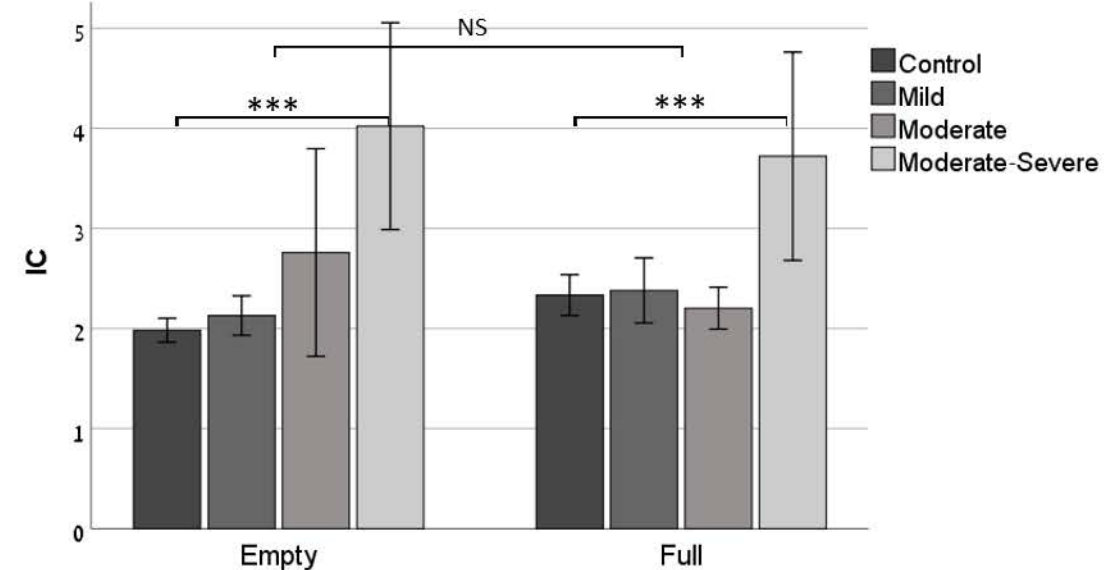
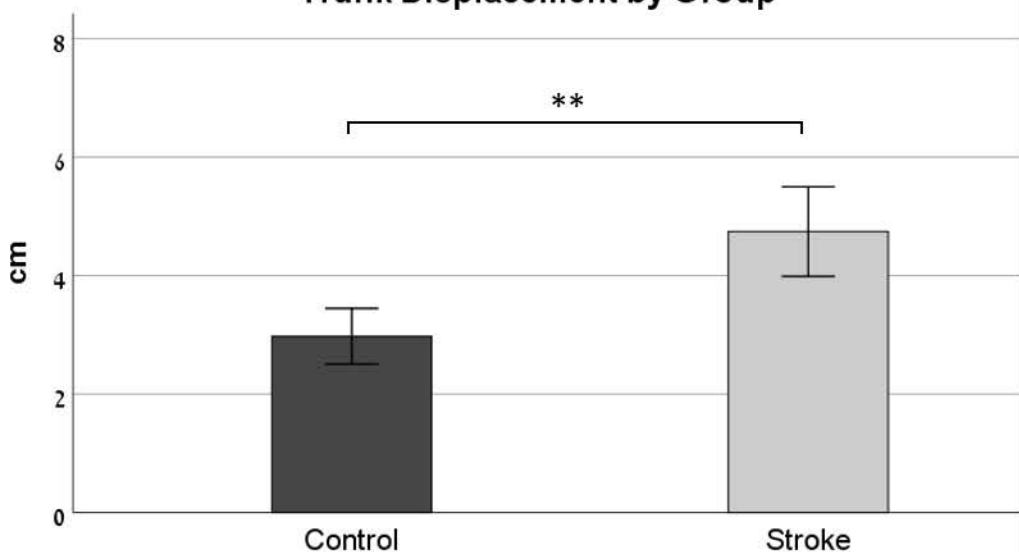
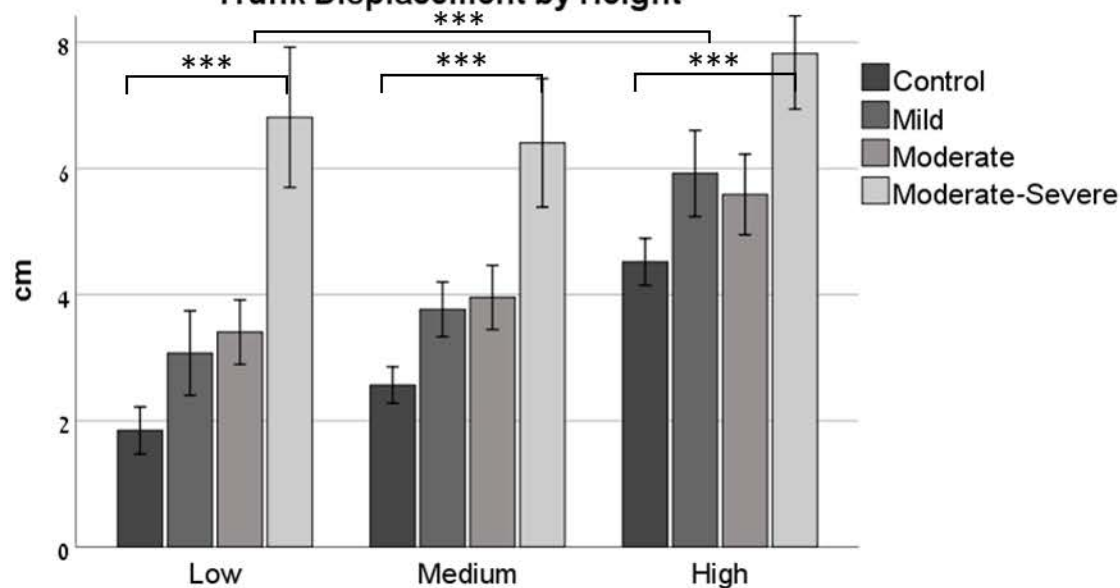


Figure S5. Index of Curvature (IC). IC values for the Reach phase (*left*), and the Lift phase (*right*). The top row shows the results by group (control/stroke). The middle row shows the results by height (low/medium/high), and by sub-group (control/mild impairment/moderate impairment/moderate-severe impairment). The bottom row shows the results by weight (empty/full cup, corresponding to light/heavy weight), and by sub-group. Asterisks denote the p -value: * p <0.05, ** p <0.01, *** p <0.001 Abbreviations: NS-not significant.

Trunk Displacement by Group



Trunk Displacement by Height



Trunk Displacement by Weight

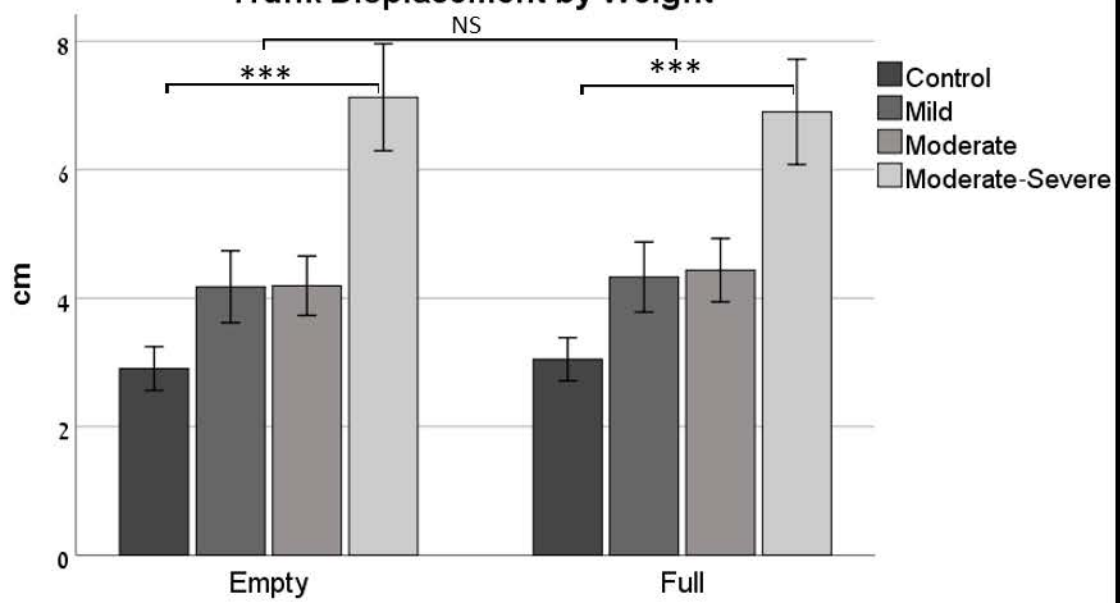


Figure S6. Trunk Displacement (TD). TD represents the change of the trunk position in centimeters from T1 to T4. The top row shows the results by group (control/stroke). The middle row shows the results by height (low/medium/high), and by sub-group (control/mild impairment/moderate impairment/moderate-severe impairment). The bottom row shows the results by weight (empty/full cup, corresponding to light/heavy weight), and by sub-group. Asterisks denote the p -value: $*p \leq 0.05$, $**p < 0.01$, $***p < 0.001$ Abbreviations: cm-centimeters.